PETROGRAPHY and PETROLOGY

of the

CAMERON RIVER VOLCANIC BELT N.W.T.

R. W. EDIE

APRIL 1949

Pillow Lavas

of the

Yellowknife Group

southeast of

Gordon Lake

Northwest Territories

Photograph by J. F. Henderson,

Geological Survey of Canada.

PETROGRAPHY AND PETROLOGY

OF THE

CAMERON RIVER VOLCANIC BELT

DISTRICT OF MACKENZIE, N.W.T.

by

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A Thesis

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ABSTRACT

The Cameron River volcanic belt, located fifty miles northeast of Yellowknife, N.W.T., consists of a steeply dipping Archean assemblage of volcanic rocks and intercalated sills. The belt strikes north, is overlain stratigraphically by a thick series of greywacke type sediments to the west, and intruded by a granodiorite batholith to the east.

The volcanic rocks are largely light to dark green weathering pillowed lava flows, with minor interbedded agglomerate and tuff. The younger lava flows are more sialic than the older; basalt, andesite, dacite and finally rhyolite were successively extruded.

The sills, which were injected along agglomerate horizons, consist of dark green weathering gabbro and diorite.

The volcanic rocks and intercalated sills have been regionally metamorphosed. As the granodiorite contact is approached from the western part of the belt, there is a progressive increase in metamorphic grade. In the lowest grade of metamorphism, the basaltic and andesitic rocks consist chiefly of secondary feldspar, chlorite, and epidote. At a higher grade, hornblende appears, and with increasing metamorphism gradually takes

the place of chlorite and other primary dissociation products. In the highest grade of metamorphism, the rocks consist almost entirely of hornblende and plagioclase and are plagioclase-amphibolites.

The research undertaken consisted largely of a study of thin sections of the metamorphosed volcanic rocks. Since most of the secondary plagioclase feldspar is untwinned, the composition was determined by immersion in an oil of known refractive index.

A chemical analysis of the granodiorite showed a high content of soda (4.48% Na_2O) as compared to the soda content of normal granodiorites (3.29% Na_2O). Calculation of the norm indicates that this intrusive rock is a sodaclase granodiorite (Johannsen, vol.II p.312)

INTRODUCTION

GENERAL STATEMENT

Since the initial mineral discovery in 1934, the Yellowknife Bay area N.W.T. has been noted for its spectacular gold deposits. (Lord, 1941) Although the chief interest has centered around Yellowknife Bay itself, a good deal of exploration has been done in the surrounding district. The Prospect Street Syndicate was organized in 1946 in order to explore a belt of volcanic rocks along the Cameron River, some fifty miles northeast of Yellowknife.

LOCATION OF MAP-AREA

The map-area covers only part of the belt of volcanic rocks which trend in a northeasterly direction along the Cameron River. This belt is shown on Plate IV, Geology of the Yellowknife-Beaulieu area and Plate I, Geological Survey map 645A, Gordon Lake South, District of Mackenzie.

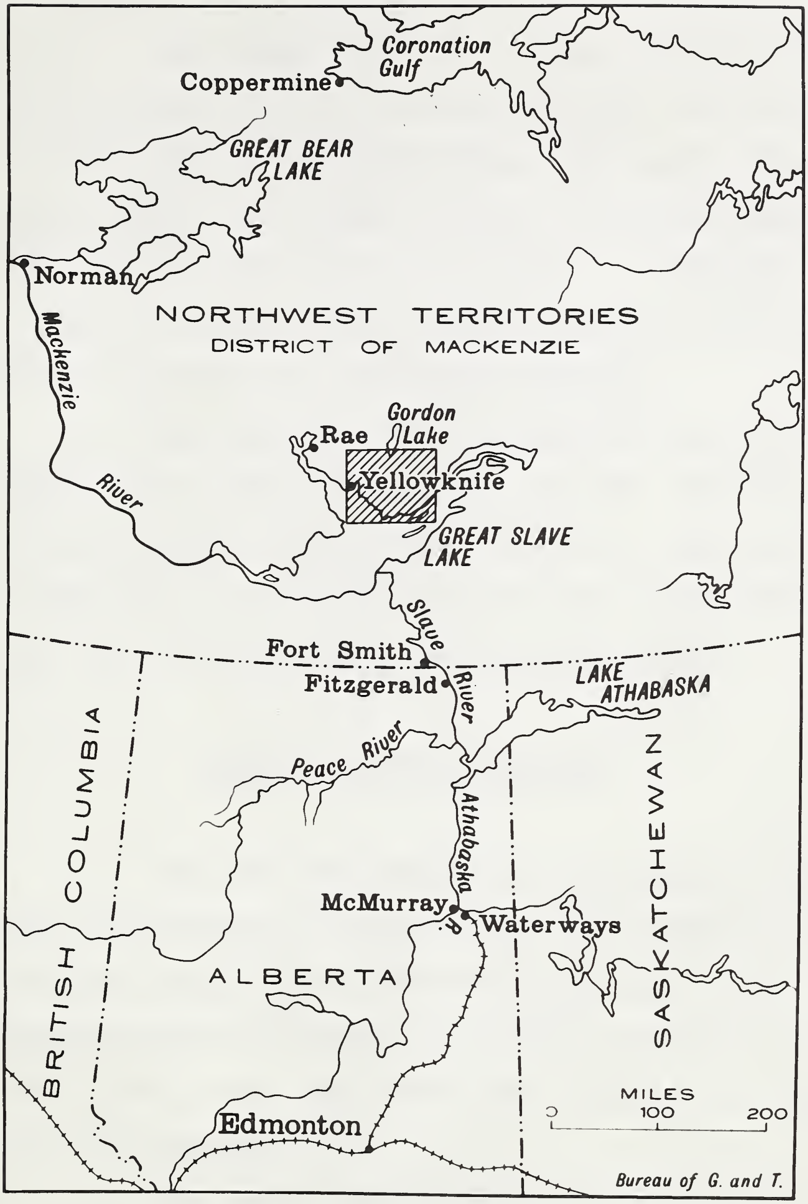
PLATE III

Location

of

Yellowknife-Beaulieu Area

After Geological Survey of Canada


Coronation Gulf
Coppermine
GREAT BEAR LAKE
Norman
NORTHWEST TERRITORIES
DISTRICT OF MACKENZIE
Mackenzie River
Gordon Lake
Rae
Yellowknife
GREAT SLAVE LAKE
Slave River
Fort Smith
Fitzgerald
LAKE ATHABASKA
Peace River
BRITISH COLUMBIA
Athabaska R.
McMurray
Waterways
ALBERTA
SASKATCHEWAN
MILES
0 100 200
Edmonton
Bureau of G. and T.

FIELD WORK

The author spent two seasons on the Cameron River volcanic belt and during that time was in charge of field work for Prospect Street Syndicate. The first season, 1946, was devoted chiefly to initial prospecting which was rewarded with some success. During the summer of 1947, the exploration program consisted chiefly of diamond drilling and geological mapping.

The mapping, which covered an area of about three square miles, was carried out with the aid of enlarged aerial photographs. The scale used was one inch to 500 feet. In reproducing this map for the thesis, the scale was reduced to one inch to 1,000 feet.

SCOPE OF THESIS RESEARCH

The research consisted primarily of a microscopic examination of twenty-seven thin sections of rocks collected by the author from the map-area. These thin sections are considered to be fairly representative of the various rock types which were employed as units in the field mapping.

The microscopic examination was made in order to determine the mineralogical assemblages, textures and structures of the rocks. This information, coupled with a chemical analysis of the granitic intrusive was used to

PLATE IV

Geology

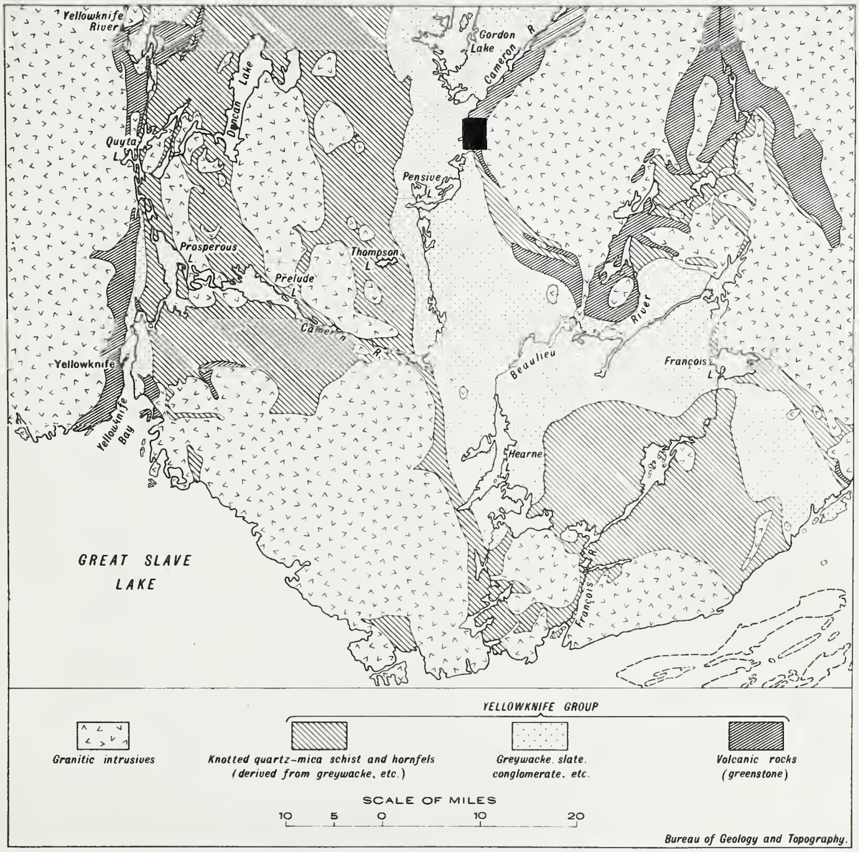
of

Yellowknife-Beaulieu Area

After Geological Survey of Canada

Thesis portion of Cameron River

volcanic belt shown in black


Yellowknife River
Gordon Lake
Cameron R.
Duncan Lake
Quyta L.
Pensive L.
Prosperous L.
Thompson L.
Prelude L.
Cameron R.
Yellowknife
Yellowknife Bay
Beaulieu
River
François L.
Hearne L.
François R.
GREAT SLAVE LAKE
YELLOWKNIFE GROUP
Granitic intrusives
Knotted quartz-mica schist and hornfels (derived from greywacke, etc.)
Greywacke, slate, conglomerate, etc.
Volcanic rocks (greenstone)
SCALE OF MILES
10 5 0 10 20
Bureau of Geology and Topography.

interpret the petrogenesis of the rocks, that is, their origin and subsequent geological history.

ACKNOWLEDGMENTS

The research and preparation of this thesis has been made possible by the assistance and co-operation of a number of individuals and organizations. The author wishes to express his appreciation for the financial assistance given under the "Shell Oil Fellowship for Research".

Through courtesy of Francis P. Webb and the late Gerald D. Murphy of Prospect Street Syndicate, kind permission was granted to present geological field information. The author also wishes to acknowledge assistance rendered in the field by his wife Beth E. Edie, Herbert G. Little and W. Graham Campbell.

The assistance and guidance given by members of the Department of Geology at the University of Alberta, is gratefully acknowledged. Thanks are especially due to Dr. J. A. Allan, Dr. R. L. Rutherford and Dr. R. E. Folinsbee.

PLATE V

Waterfront View

Yellowknife Northwest Territories

August 1947

Camp of Prospect Street

Syndicate, Murphy Lake

May 1947

PREVIOUS WORK

General Statement

Exploratory geological mapping was done in the Yellowknife-Beaulieu area in 1931 and 1932 by C.H. Stockwell and by A.W. Jolliffe in 1935. Reconnaissance mapping of the Beaulieu River area (1 inch to 4 miles) was done by J.F. Henderson in 1937 and 1938 and by A.W. Jolliffe in 1937. Detailed mapping (1 inch to 1 mile) of part of this area in 1939 resulted in the publishing of map 645A, Gordon Lake South by J.F. Henderson. A copy of this sheet is included with the thesis (plate I). The most recent work in the Beaulieu River area was done by Y.O. Fortier in 1943, 1944, and 1945. His map, Ross Lake, adjoins immediately to the south of sheet 645A.

Summary Statement of Formations

In his report on the Beaulieu River area, 1939, Henderson gives the following summary statement of formations.

Late Precambrian

Diorite, Gabbro (sills and dykes)

Great Slave Group

Conglomerate, arkose

Early Precambrian

Granite, granodiorite, and allied rocks

Diorite, gabbro etc.

Yellowknife group

Greywacke, impure quartzite and arkose, slate and argillite, quartz-mica schist and hornfels.

Basalt, andesite, dacite, rhyolite, tuff, agglomerate, diorite and gabbro

Only the underlined of the above formations are dealt with in this thesis. There were no sedimentary formations in the area mapped by the author.

SOME CONCEPTS OF REGIONAL METAMORPHISM

General Concepts and Definitions

Metamorphism is broadly defined as any change, physical or chemical, in a rock. However, as practically all rocks have been modified to some slight degree since they were formed, the term metamorphism is commonly reserved for those extensive changes involving new crystallization or new textures throughout the body of the rock -- usually those changes below the belt of weathering involving higher temperatures than those normal at the surface. (Grout, 1932, p.375)

Regional metamorphism is defined by Turner (1948) as metamorphism over wide areas under the combined influence of raised temperatures, variable pressure, and high shearing stress, all of which vary through a wide range of intensity.

Recrystallization is one of the most prominent of metamorphic processes. It is essentially constructive, and minerals are commonly enlarged or new ones are formed by it. The new crystals may be of the same composition as the original or may be products of reaction. No change in the total composition of the rock is necessitated, but heat and water are so universal that some changes in

hydration are common and more or less addition or loss of other materials is not rare. (Grout 1932, p.405)

The physical conditions that bring about and control metamorphism are temperature, pressure, and shearing stress. A fourth factor, of great importance in facilitating and accelerating chemical and mechanical adjustments to these conditions, is the chemical activity of aqueous solutions and gases percolating through the intergranular network of the rock. Temperature is the principal condition determining the nature of the assemblage of minerals produced by metamorphism of a rock of a given composition. Pressure also has some direct influence in this connection. High shearing stress, developed during the metamorphic deformation of rocks, usually under high confining pressures, not only directly determines the structure of the metamorphic rock but, like the circulating pore solutions, facilitates chemical reaction. The mineral assemblage produced also is possibly determined partly by the intensity of the shearing stress during chemical reconstitution of the rock. (Turner, 1948, p.4)

The conception of metamorphism to be kept constantly in mind is that it is of a progressive nature. In response to rising temperature, the substance of a given rock passes through a certain sequence of transformations, the stage actually reached depending upon the highest temperature attained. In the original rock,

however, there are, in most cases, some constituents which are more susceptible to change than others, in the sense of being affected at an earlier stage of the rise in temperature. They may dissociate, or react with one another, or merely recrystallize. In any early grade therefore such a rock is only partially metamorphosed. It consists partly of new and recrystallized minerals, partly of "residual" minerals still intact. With continued rise of temperature these are in turn drawn into the sphere of the process of metamorphism; so that in any advanced grade the rock may be regarded as totally reconstituted. (Harker, 1932, p.12)

A number of textural terms applying to the preceding discussion of metamorphic rocks have been extensively used throughout this thesis. Some of these terms are defined by Tyrrell (1941) as follows:

Crystalloblastic -- a texture in metamorphic rocks in which complete recrystallization has taken place. It does not show a hiatus in grain size.

Blastophitic -- a texture in metamorphic rocks wherein original ophitic texture is recognizable.

Blastoporphyritic -- a texture in metamorphic rocks wherein original porphyritic texture is recognizable.

Palimpsest -- a texture in metamorphic rocks wherein remnants of original minerals or textures are preserved.

Porphyroblastic -- a texture in metamorphic rocks in which metacrysts form large crystals embedded in a fine grained groundmass, like the phenocrysts of a porphyritic igneous rock.

One of the earliest men to demonstrate the possibility of mapping zones of progressive regional metamorphism was Barrow. His work was carried out on the Dalradian schists of the Highlands of Scotland. The Dalradian schists are regionally metamorphosed geosynclinal sediments. Injection of granite magma in the deeper levels contributed in some measure to local elevation and maintenance of high temperature. Increase in degree of metamorphism was correlated directly with rise in temperature so that isograds (lines of equal metamorphic grade) were also isothermals. Each zone of progressive metamorphism is defined by an index mineral, the first appearance of which (in passing from the low to higher grades) marks the outer limit of the zone in question. Barrow chose pelitic (argillaceous) rocks, both on account of their wide distribution in the Dalradian and because of their sensitivity to variations in temperatures and pressures. The sequences of index minerals, in order of increasing metamorphic grade, is chlorite, brown biotite, almandine, staurolite, kyanite, silimanite. (Turner, 1948, p.36)

Metamorphism of Basic Igneous Rocks

Basic igneous rocks are also sensitive to temperature variations and may therefore be used in metamorphic zoning. In derivitives of basic igneous rocks, association of chlorite with albite at low grades, and of hornblende with more calcic plagioclase at medium and high grades is characteristic. However, neither chlorite nor amphibole is a satisfactory zonal index since, as shown especially by the work of Wiseman (1934), chlorite survives throughout the biotite zone as defined for associated pelitic schists, while the high-grade hornblendes merge into actinolitic amphiboles that are stable under some conditions even at the lowest grades within the zone of chlorite. (Turner, 1948, p.39)

The original minerals of basic igneous rocks are chiefly calcic plagioclase, augite, olivine, and iron ores, including both ilmenite and magnetite. The anorthite molecule of plagioclase is unstable under regional metamorphism, and breaks up into zoisite, epidote, prehnite, etc., with the liberation of the albite. Under low grade metamorphism the products of the alteration merely psuedomorph the feldspars as a very dense microgranular mixture. This substance is known as saussurite and the alteration is called saussuritisation.

At an early stage of metamorphism any ferromagnesian mineral may break down into chlorite. The alteration of pyroxenes to chlorite frequently gives rise to calcite and quartz as by-products. In the next stage of metamorphism, hornblende may be produced directly from pyroxene, and epidote or zoisite and quartz may develop as by-products of the change. This process is known as uralitisation; the secondary hornblende psuedomorphous after augite being called uralite. Dr. C.E. Tilley states that the hornblende may arise by chemical interaction between chlorite and calcite, or between chlorite and epidote, both reactions requiring the addition of silica. (G.W. Tyrrell, 1941, p.310-311)

In the Dalradian and Moine series of Scotland a number of basic sills have been intruded at numerous horizons and subsequently metamorphosed in common with those strata. Their grade of metamorphism can therefore be correlated with the scheme of zones already established for the pelitic sediments, and representatives are found in every grade from the lowest to the highest. The primary minerals of these rocks were presumably chiefly basic plagioclase and pyroxene. In the lowest grade is a calcite-albite-chlorite-schist and next an albite-epidote-chlorite-schist, which may still carry calcite in greater or less amount. The next step is marked by the production of hornblende, still within the chlorite zone as indicated by the associated sediments. The

mineral appears first as slender needles embedded in the chlorite and sometimes enclosed in the albite. With progressive development of hornblende in this and the succeeding (biotite) zone, the chlorite rapidly dwindles, and the epidote is somewhat reduced in amount. Little granules of sphene appear about the same time. There is thus a distinctive type of albite-epidote-hornblende-schist, in which hornblende gradually becomes the principle constituent. Hornblende continues to be the characteristic mineral in most higher grades, and the rocks may accordingly be named amphibolites. The absorption of feldspar-substance into the hornblende is found especially in the highest grade of metamorphism. In entering the garnet zone, chlorite soon disappears, and the feldspar passes through oligoclase to andesine. The epidote minerals may, however, survive in part well into the garnet-zone, giving as a recognized type an epidote-amphibolite. Failing this, the rock is simply a plagioclase-amphibolite. In the highest grades of metamorphism (kyanite and sillimanite zones) the mineralogical constitution is generally the same, but the rocks are of coarser texture, and often show little or nothing of a schistose character. From amphibolites in the ordinary sense, they pass to hornblende-plagioclase-gneiss. The feldspar is commonly a medium andesine. (Harker, 1932, p.278-285)

Metamorphism of Intermediate and Acid Igneous Rocks

Metamorphism of rocks of intermediate and acid composition follows the same general lines as before, but with mineralogical differences such as are easily predicable from the different bulk-composition of the rocks. In the lowest grade a rock of mean acidity is represented by a calcite-albite-sericite-chlorite-schist, and this is succeeded by albite-epidote-sericite-chlorite-schist. These differ from the corresponding basic types by the coming in of a certain amount of white mica and quartz and usually by a higher content of albite as compared with chlorite and the lime minerals. The early formation of acicular hornblende, which was a noteworthy feature in the former case, is not found here, but hornblende makes its appearance with advancing metamorphism, as chlorite and epidote dwindle. Biotite also becomes a prominent constituent, with or without some muscovite, and such rocks may be styled biotite-hornblende-schists. The feldspar at this stage is oligoclase. Of the still higher grades of metamorphism in rocks of this kind there is less certain knowledge.

The intermediate rocks comprise a wide range of bulk-analysis. In passing from sub-basic to sub-acid rocks, quartz, potash-feldspar, and micas increase in amount, while chlorite, epidote, and hornblende decrease. The plagioclase too, becomes more restricted

to the sodic end of the series, even in the most highly metamorphosed types.

In rocks of definitely acid composition, the proportion of chlorite and epidote is further reduced, and hornblende does not form. Quartz is more abundant, and white mica is the next constituent in importance. When the primary minerals have been completely broken down the lowest grade is a sericite-schist. There is usually sufficient chlorite and iron-oxide present to give rise in due course to biotite but failing this a muscovite-quartz-schist is formed. Sericitization of the feldspar may begin and be completed at an early stage; but this is dependent upon the conditions and in particular upon a sufficient quantity of water. The reverse change, from mica to feldspar, belongs to an advanced grade. Biotite may become dissociated too, and its place taken by a red garnet. The final product is a gneissic rock often with a granoblastic or granulitic fabric. (Harker, 1932, p.286-290)

II PETROLOGY OF THE CAMERON RIVER VOLCANIC BELT

GENERAL STATEMENT

The Cameron River volcanic belt shown on plate I, runs northwest from Ross Lake and then swings north and northeast along Cameron River. It ranges in width from a fraction of a mile to two miles. The belt consists of lava flows with some interbedded tuff and agglomerate and minor intercalated sills. The volcanic rocks and associated sills form the oldest member of the Yellowknife group and are of Archean age.

Along the contact with the overlying sedimentary rocks, the flows strike parallel to the contact. According to Henderson (1943), they are vertical or overturned so that they dip at angles of 90° to 75° east and southeast. Some of the flows contain well-preserved pillow structures from which excellent determinations of the attitude can be made. All observations throughout the belt indicate that the flows top west and northwest;

the structure is thus a homocline formed by almost vertical flows facing west and northwest.

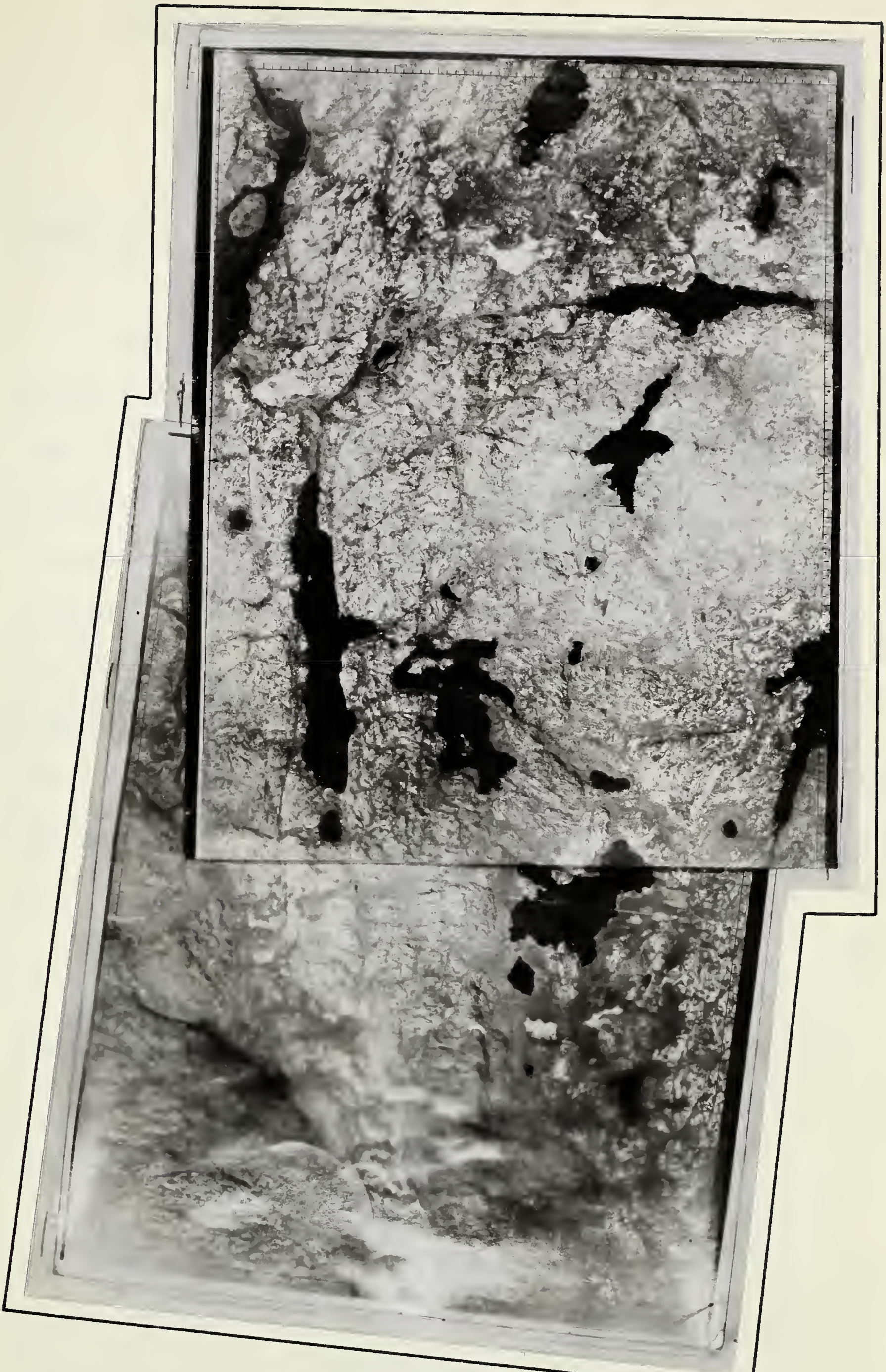
The Cameron River volcanic belt is in contact with a granitic batholith to the east. This contact clearly shows an intrusive relationship indicating that the granitic rocks are younger than the rocks of the volcanic belt.

The youngest rocks of the map-area are diabase dykes which strike in a northwesterly direction.

PLATE VI

Photostatic Reproduction
of aerial photographs
covering the area mapped,
Cameron River Volcanic Belt, N.W.T.
Photographs A5598-60 and A5598-94

Reproduced by permission of the
Royal Canadian Air Force



VOLCANIC ASSEMBLAGE AND ASSOCIATED SILLS OF THE YELLOWKNIFE GROUP

Field Occurrence and Microscopic Description

Basalt, Massive (1a) - A number of medium grained massive flows which weather dark greenish-grey comprise this phase of the volcanic rocks. On the whole, the flows are devoid of pillow structure although locally a few poorly defined pillows were recognized. Because of the scarcity of flow structures in these rocks, they are in certain instances, difficult if not impossible to distinguish from intrusive sills of like appearance. In the eastern part of the map-area (plate II), the massive basalts grade into recrystallized types classed as greenstone (2).

Field mapping shows the massive basalt rocks to range in thickness from less than 100 to over 800 feet. The thicker masses probably represent a number of flows because discontinuous agglomerate beds occur within them.

The chief constituents of these rocks are hornblende (50 to 60%) and andesine (35 to 45%) with minor amounts of ilmenite. A thin section from near the east shore of Murphy Lake (slide E 14) shows palimpsest texture with some primary feldspar, whereas a

Basalt, massive (la), thin section E 14, crossed nicols, X 60.

The rock is an andesine-amphibolite composed chiefly of fibrous hornblende (dark) and recrystallized andesine (light). The slide shows palimpsest texture; a relict crystal of primary feldspar (upper part of photo) exhibits multiple albite twinning.

Greenstone (2), thin section E 24, ordinary light, X 60.

The rock is an oligoclase-amphibolite consisting mainly of hornblende (dark) and oligoclase (light). The texture is crystalloblastic, coarse grained. A few needles of apatite are imbedded in the oligoclase.

Due to its proximity to the granodiorite contact, this rock belongs to the highest metamorphic grade represented in the map-area.

specimen about 1700 feet farther east (slide E 16) is completely recrystallized. Ilmenite which is partly altered to leucoxene, appears to be a primary mineral but the hornblende is regarded as a product of recrystallization.

In thin section, there is no evidence of original structures which would serve to distinguish flows from sills. If any such evidence did exist, it has been obliterated by metamorphism.

Greenstone (2) - These rocks are recrystallized volcanics derived from massive basalt (1a). In the field they appear as medium to coarse grained olive-grey weathering rocks. Weathered surfaces are, as a rule, pitted, due to differential weathering of the less resistant feldspar.

The greenstone, occurring in the eastern part of the map-area, is riddled with narrow granitic intrusives of no particular shape nor pattern. The greenstone in all cases is not uniform. Frequently streaks or bands of markedly schistose material are noticeable on an outcrop. These bands are as a rule less than two feet wide and generally are highly contorted. Their schistose nature is attributed to high biotite content. Although the author did not collect any of the schistose type for thin section study, glistening flakes of biotite were observed on fresh surfaces of this rock.

A thin section of rock of generally massive character (E 24) shows the chief minerals to be hornblende (45%) and oligoclase (35%) with minor amounts of biotite, quartz and ilmenite. The texture is crystalloblastic. Ilmenite, in part altered to leucoxene, is regarded as the only primary mineral.

Basaltic Agglomerate and Tuff (1b) - Basaltic agglomerate and tuff beds occur chiefly in lenticular masses amongst the older basaltic flows. The maximum thickness of the agglomerate and tuff is less than 200 feet and no agglomerate or tuff horizon can be traced for more than 1500 feet along strike. Most of these beds appear to be heterogeneous mixtures of pyroclastic material. Fragments of bomb and lapilli size may frequently be observed. The fragments characteristically weather with a pitted brownish surface as contrasted with the relatively smooth dark greenish grey surface of the matrix.

A few narrow bands of agglomerate material appear to grade into tuff at the top. A slight color banding suggests stratification within this fine grained material. Light olive-grey laminae alternate with those of a darker greenish color.

Microscopically, the basaltic agglomerates and tuffs vary a great deal in mineralogical composition. (thin sections E 9, E 10, E 11, E 12) The agglomeratic

PLATE VIII

Basaltic tuff (1b), thin section E 10, ordinary light, X 60.

The rock is a biotite-labradorite-hornfels consisting chiefly of biotite (dark) and labradorite (light). Small ilmenite crystals (black) are scattered throughout the slide. The high biotite content is probably due to contamination of original basic tuff by muds of sedimentary origin.

Basalt, pillowed, coarse grained (1d), thin section E 23, ordinary light, X 60.

The rock is an andesine-amphibolite consisting chiefly of large lath-like crystals of hornblende (dark) in a matrix of secondary feldspar (light). Small crystals of ilmenite (black) are scattered throughout the slide.

rocks consist mainly of hornblende, labradorite and quartz with minor amounts of ilmenite and biotite. Of two tuff beds investigated, one has a similar composition to the agglomerates, but another is radically different. The predominant minerals in this rock are biotite and labradorite with minor amounts of hornblende, quartz and ilmenite.

All of the basaltic agglomerate and tuff rocks exhibit crystalloblastic textures. Of the four slides examined, three showed slight schistose structure with slight mineralization consisting of pyrrhotite, carbonate and pyrite.

Basalt, pillowed, fine grained (1c) - These flows constitute a considerable portion of the early succession of irrupted material. They are characterized by well developed pillow structure. In a few instances, however, these rocks were observed to grade into massive types. (1a)

The typical pillowed basalts are fine grained, greenish-black weathering rocks. Quartz amygdules, 1/8 to 1/4 inch in diameter, are common. The pillows appear bean shaped and their outer covering is usually about one half inch thick. On the weathered surface, this shell invariably weathers out to form a "U" shaped trough marking the boundaries between ellipsoids.

The characteristic shape of pillows can be used to determine the attitude of beds. In all instances where pillows were closely examined, the tops indicated that the successively younger flows were to the west. The long axes of the pillows vary from less than a foot to over four feet. These axes strike in general, parallel to the local trend of formations.

A thin section (E 13) of one of these flows shows the principal constituents to be hornblende (70%) and basic plagioclase (15%) with minor amounts of quartz, clinozoisite and ilmenite. The texture is crystalloblastic. Quartz is considered to be primary amygdule filling and ilmenite too, is believed to be of a primary nature. Hornblende, plagioclase and clinozoisite however, are regarded as the products of recrystallization.

Basalt, pillowed, coarse grained(1d)- These rocks form a distinct variety of pillow lavas. Their occurrence is restricted to the southern part of the map-area, where they form a mass some 700 feet thick and 3800 feet long.

In appearance, these rocks are medium to coarse grained and weather to a mottled greenish-black and pinkish-grey color. Acicular hornblende crystals in a matrix of feldspar are readily discernible in the hand specimen.

In comparing these rocks with the finer grained pillowed basalts (1c), there is commonly a marked difference in pillow structure. In the coarser grained flows, the margins of the pillows are much thicker, generally one to two inches wide. Moreover, these borders are less distinct but they do present unmistakable evidence of pillow structure.

A thin section (E 23) indicates that the principal minerals of these rocks are hornblende and andesine in nearly equal proportions with a minor amount of ilmenite. Of these, ilmenite is considered to be the only primary mineral and the texture is crystalloblastic.

Feldspar porphyry flow, large phenocrysts (1e) - This porphyritic flow rock is one of the best horizon markers in the map-area and may be traced on strike for a distance of over 7000 feet. Its average thickness is about 200 feet but locally it swells to a thickness of 500 feet.

Characteristically, this rock exhibits an uncommon type of porphyritic texture. Phenocrysts of white weathering feldspar about the size of hens eggs are widely scattered throughout the rock. On an outcrop, it is usual to find only one or two phenocrysts within an area of a square yard although locally they may appear more numerous. The groundmass of the rock is medium grained and weathers to a dark greenish-grey color.

Microscopically, this rock consists chiefly of oligoclase, chlorite and hornblende, and is andesitic in composition. (thin section E 22) Small amounts of biotite and titaniferous magnetite are also present. The texture is distinctly porphyroblastic; the primary feldspar phenocrysts having been completely recrystallized to a fine grained aggregate of oligoclase and chlorite.

Feldspar porphyry, small phenocrysts (1f) - This flow rock, like the porphyry previously described (1e), is a good horizon marker. It may likewise be traced on strike for a distance of over 7000 feet. Its thickness varies from about 50 to 150 feet.

The chief difference between this rock and the previous porphyry (1e) is the number and size of phenocrysts. White weathering phenocrysts of feldspar up to an inch in diameter are quite numerous, and locally may comprise ten percent of the rock. The phenocrysts give the flow the general appearance of the "bird porphyry" which is common amongst the volcanic rocks of the Yellowknife Bay area.

The flow shows pillow structure but this is rather poorly developed and in fact may be absent altogether in certain places.

A thin section of the groundmass of this rock shows the principle constituents to be hornblende, chlorite and oligoclase in about equal proportions, with a minor amount of ilmenite. (thin section E 21) The rock is andesitic in composition. The texture is fine grained and appears to be blastophitic. Except for the ilmenite, all of the constituent minerals are considered to be of metamorphic origin.

Andesite, massive (1g) - These rocks are quite widespread among the younger flows in the western part of the map-area. A mass of this rock over 900 feet thick outcrops south of Murphy Lake but in general accumulations of this material are much thinner.

In the field, these flows weather to a light greyish-brown color. They are generally massive and devoid of pillow structure although locally a few poorly defined pillows are present.

Under the microscope, a thin section shows the chief minerals to be andesine, chlorite, lawsonite, epidote, quartz and ilmenite in decreasing order of abundance. (thin section E 7) The texture is chrystalloblastic and with the exception of ilmenite, all of these minerals are considered to be products of recrystallization. The particular slide illustrates the effect of saussuritization and chloritization of primary minerals of the rock.

PLATE IX

Andesite, massive (lg), thin section E 7, ordinary light, X 60.

The rock is an andesine-chlorite-epidote-hornfels and belongs to the lowest grade of metamorphism represented in the map-area. It consists chiefly of the dissociation products of primary feldspar and pyroxene; a microcrystalline aggregate of andesine, chlorite, lawsonite, epidote, and quartz. Clusters of ilmenite crystals (black) are scattered throughout the slide.

Andesitic tuff (lh), thin section E 3, ordinary light, X 60.

The rock is a quartz-biotite-schist. The lower part of the photo consists largely of andesine with numerous inclusions of biotite and the upper part of quartz (relatively light) with only minor inclusions of biotite. Some of the andesine has been replaced by quartz and the serrate structure is due to a concentration of biotite around the edges of irregular unreplaced areas of andesine.

Andesitic Agglomerate and Tuff (1h) - These fragmental rocks weather light grey to buff and are irregularly distributed amongst the later flows of the map-area. They are of a lenticular nature and can seldom be traced for more than fifteen hundred feet. Their average thickness is about fifty feet.

On the weathered surface, some of these beds show fragments of bomb and lapilli size in a fine grained matrix. Others are more uniformly fine grained and these are apt to be cherty. In a number of places, there is a suggestion of stratification in the finer grained beds.

A thin section of a fine grained cherty tuff from the northeast shore of Murphy Lake shows the mineral constituents to be largely mica, quartz, and andesine in decreasing order of abundance. The mica, which is responsible for the slight schistosity of the rock, appears to vary in composition from pale green sericite to reddish-brown biotite. The rock is highly silicified; in certain areas of the thin section, the feldspar has been completely replaced by fine grained quartz. The texture is crystalloblastic and no significant amounts of primary minerals were recognized.

Andesite, pillowed (1i) - Andesitic pillow lavas are largely confined to the western part of the map-area. Masses of this rock vary from less than fifty to over five hundred feet in thickness. The largest mass contains

a considerable portion of interbedded agglomeratic material and can be traced for about 5000 feet. However, most of the bands of lava are continuous for less than a thousand feet.

The flows are fine to medium grained rocks and are characterized by their light greenish-grey weathered surfaces as contrasted to the darker basaltic types. Pillow structure is generally well developed and is similar to that observed in more basic types. In places, however, these flows appear to grade into flow breccias. In one locality, about 1500 feet east of the northern part of Murphy Lake, the pillows are variolitic. Spherules, about the size of peas, weather out along the inside edge of the pillows.

A thin section (E 5) of a flow from an outcrop about five hundred feet west of Murphy Lake shows the following mineralogical composition: Oligoclase 45%, hornblende 30%, chlorite 15%, ilmenite 5% and biotite 4%. A section (E 6) of a similar appearing flow about 1600 feet farther east shows a composition as follows: oligoclase 55%, hornblende 35%, ilmenite 4%, biotite 2% and chlorite 1%. These slides show a significant difference in the relative proportions of feldspar, hornblende and chlorite. Both slides show crystalloblastic texture, with ilmenite the only mineral considered primary.

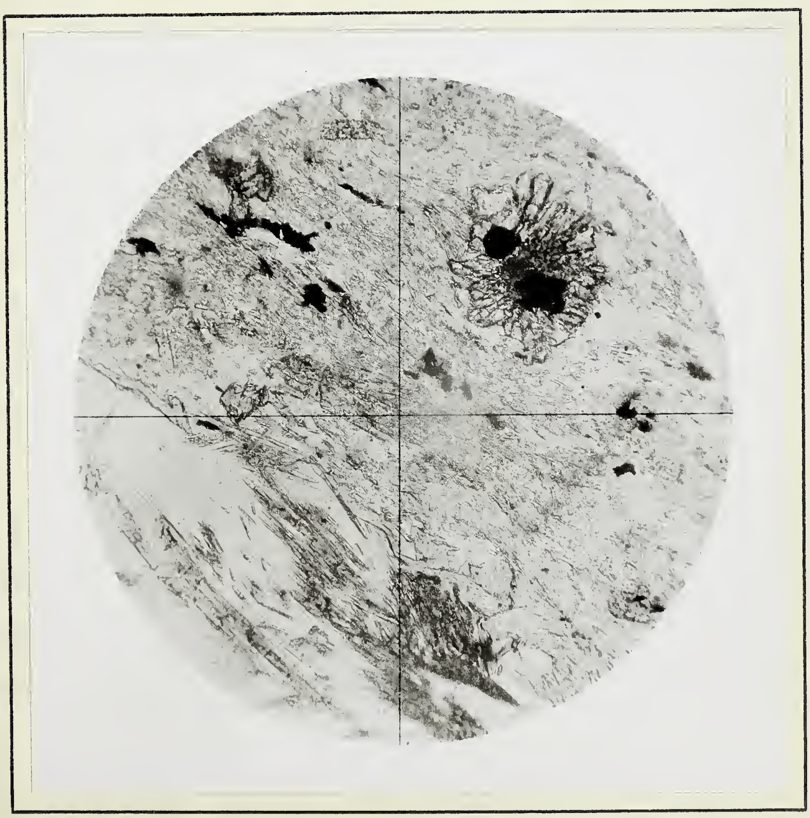
PLATE X

Andesite, pillowed (li), thin section E 6, ordinary light, X 60.

The rock is an oligoclase-amphibolite composed chiefly of fibrous hornblende (dark) and secondary feldspar (light). Ilmenite crystals (black) are scattered throughout the slide. The texture is crystalloblastic.

Flow breccia, dacitic (li), thin section E 4, ordinary light X 60.

The rock is an andesine-quartz-chlorite-schist. The groundmass (clouded) consists of secondary feldspar with numerous fine poikilitic inclusions of chlorite. In the photo (upper right) is an aggregate of radiating clinozoisite crystals (high relief). In the lower left part of the photo fibrous actinolite occurs in an area of clear quartz, probable amygdule filling.



Flow Breccia, dacitic(1j)- Rocks of this type are the dominant lavas in the northwest part of the map-area. A continuous band of this material may be followed for a distance along strike of over six thousand feet. The band pinches out west of the north end of Murphy Lake but is still continuous at the north boundary of the map-area. The average width of the band is about one thousand feet.

The rock typically weathers to a light olive-grey color and is fine to medium grained. Angular fragments are usually lighter in color than the matrix and frequently project about the general surface due to differential weathering.

Under the microscope (thin section E 4), the rock appears to consist chiefly of andesine, chlorite, and quartz in decreasing order of abundance, with minor amounts of actinolite, clinozoisite, and ilmenite. The rock shows an amygdaloidal structure. Lenses of quartz with fibrous inclusions of actinolite are common. Clinozoisite occurs in radial aggregates and it too appears to be amygdule filling, probably as replacement of a primary unstable mineral.

Gabbro, medium to coarse grained (1k) - Intrusive sills, which grade in composition from true gabbro to diorite, are widespread throughout the map-area. They are commonly lenticular and discontinuous but some may

be traced for five thousand feet along strike. Their thickness ranges from less than fifty to over three hundred feet. The sills are commonly bounded on the top or bottom by a schistose band of agglomeratic or tuffaceous origin.

The sills are massive and coarse grained with a greenish-grey weathered surface. This surface, upon close examination, has a speckled appearance produced by dark green to black hornblende or chlorite set in a light greenish-grey feldspar matrix.

One large sill in the extreme northern part of the map-area, appears to have a porphyritic top ten to fifteen thick. On the weathered surface, light greenish-grey phenocrysts of feldspar up to one half inch in diameter, project above the darker colored matrix. Although no contact with the main gabbro mass was recognized, this porphyritic band may have been the result of composite intrusion.

In thin section, sills which are relatively close to the granodiorite contact are composed chiefly of oligoclase (25 to 45%) and hornblende (50 to 70%) with minor amounts of ilmenite (thin sections E 18, E 19). Farther to the west and northweat, the mineralogical composition is more complex (thin sections E 15, E 17, E 20). Oligoclase is predominant, chlorite the chief ferromagnesian mineral, hornblende, epidote and biotite occur in lesser amounts. The ilmenite content (five

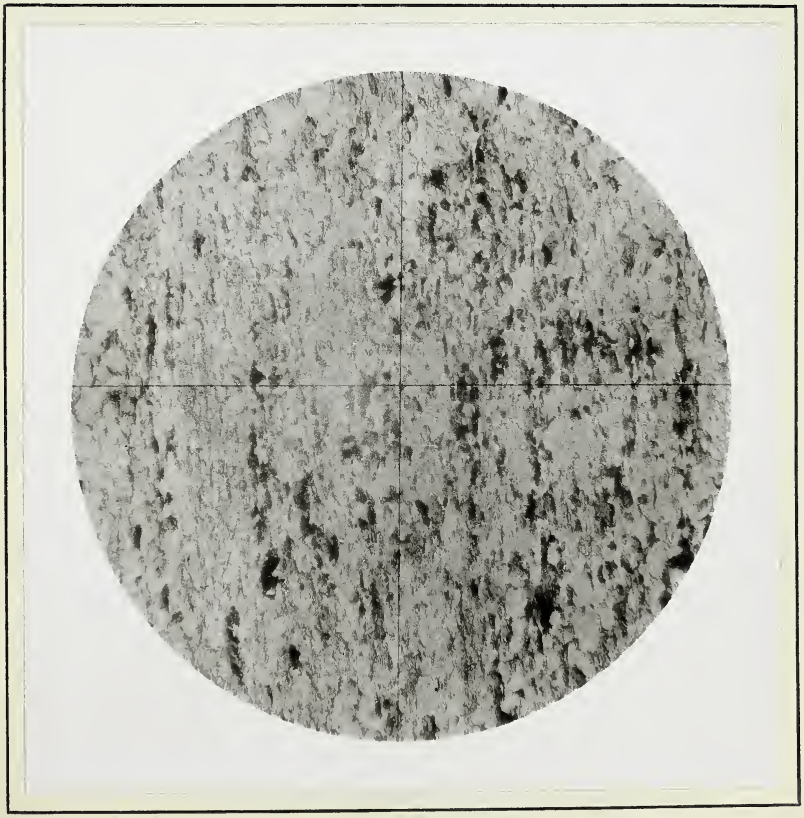
PLATE XI

Gabbro sill, (lk), thin section E 17, ordinary light, X 60.

The rock is an oligoclase-chlorite-hornblende-hornfels. The slide shows incipient growth of fibrous hornblende (dark, high relief) in chlorite (medium dark, relatively low relief). Areas of secondary feldspar (light) occur in the left-hand part of the photo.

Rhyolite (3), thin section E 8, ordinary light, X 60.

The rock is a quartz-biotite-sericite-schist. The mica varies in composition from biotite (dark) to phlogopite (medium dark) to sericite (light, cloudy). The matrix is composed of clear quartz with a small amount of primary orthoclase.



percent) is approximately the same in all slides. Textures are commonly crystalloblastic or porphyroblastic but palimpsest texture was recognized in one instance. In the lower metamorphic grades, feldspar aggregates are riddled with chlorite inclusions. This accounts for the greenish-grey weathered surface of the feldspar.

Rhyolite (3) - This rock forms a more or less continuous band in the southwest part of the map-area. It outcrops along the western slope of a high ridge which trends parallel to Cameron River. The rhyolite weathers to an almost pure white color as compared to dark greenish-grey weathering flows higher up the slope. When viewed from west of Cameron River, the ridge projects above the general landscape, and the white band of rhyolite forms a striking topographic feature visable for many miles.

The rhyolite is fine grained and slightly schistose. Locally, it exhibits characteristics typical of flow breccias.

In thin section (E 8), the rock is made up largely of mica and quartz in nearly equal amounts. The mica varies from pale green sericite to reddish-brown biotite. Orthoclase, ten percent of the slide, and quartz are considered to be primary. The mica may be in part primary but is probably largely of metamorphic origin. The texture is crystalloblastic.

Petrogenesis

In the Gordon Lake area, the volcanic assemblage is overlain stratigraphically by a thick succession of sedimentary rocks consisting chiefly of thin bedded greywacke with minor slate, impure arkose, and quartzite. Many of the greywacke beds show gradation of grain size from coarse at the bottom to fine at the top. There does not appear to be any structural unconformity between the flows and sediments, in fact interbedding of flows and sediments in places along the contact suggests that volcanism gave place to sedimentation with little or no intervening period of erosion (Henderson, 1939, p.4-5).

The association of greywacke type sediments and altered greenstones in many of the Precambrian areas of the world is not mere coincidence.

Pettijohn (1943 p.966) suggests that sediments of the geologic past have accumulated in the main, either in narrow geosynclines (eugeosynclines) or in shallow epicontinental seas (miogeosynclines). The characteristic features of eugeosynclinal sedimentation include the great thickness of the deposits, the predominance of greywackes marked by graded bedding, and the presence of associated tuff and spilitic greenstone. In contrast, the sediments of epicontinental embayments (miogeosynclines) are cross-bedded well-washed sands, pure limestones and thin bedded shales, all of slight thickness. Since the deposits of eugeosynclines are orogenically deformed and downfolded,

they tend to be preserved, whereas the undeformed and thin accumulations on the stable "platforms" are stripped by erosion. It follows, therefore, owing to the many opportunities for prolonged erosion since the Archean, that the only Archean sediments remaining today are those of eugeosynclinal or orogenic aspect.

The lava flows of the Cameron River volcanic belt appear to fit the general pattern of Archean eugeosynclinal deposition.

Along Cameron River, the volcanic assemblage is considered to be incomplete due to assimilation of lower members by post-Yellowknife granitic intrusion. Evidence of this is shown by the apparent variation in thickness of the assemblage due to truncation of the lower part by the granodiorite mass to the east. (plates I and II).

Of the volcanic rocks exposed, there is in general, a continuous gradation from altered basaltic rocks at the bottom to dacitic and rhyolitic rocks at the top.

This phenomenon seems to be an example of magma differentiation, due to crystal settling in a reservoir deep within the earth's crust (Larson, 1948, pp.162-172). However, if differentiation by crystal settling actually took place in a magma reservoir, the younger succession of flows should contain a smaller percentage of the iron ore minerals. This is not the case in the map-area, for

excepting the rhyolitic rocks, ilmenite (or titaniferous magnetite) is present in all the rocks in roughly the same proportions. The only evidence for crystallization before extrusion is the presence of large phenocrysts of feldspar in two of the rock types (1e, 1f). Although a thin section of one of these porphyritic rocks shows an apparent deficiency of the iron ore minerals, this is attributed to the fact that the section is not representative of the flow as a whole, but consists largely of one altered phenocryst.

Although no feeder dykes were recognized in the map-area, it is a well known fact that lava flows which cover large areas are formed by fissure irruption rather than from central vents. The mechanics of extrusion are unknown but this may be envisaged as follows. During the development of a geosyncline by lateral compression, extension joints form along the floor in a direction normal to the axis of the basin or tension fractures form in the arched area along the flanks of the geosyncline forming rifts parallel to the orogenic belt. Fracturing of the floor or flanks of the geosyncline periodically relieves compressional stress and confining rock pressure is drastically reduced at depth along the fissures. The fissures therefore, extend only to a depth such that the accompanying decrease in pressure has the effect of changing the rocks to the fluid state. Thus magma is generated and flows out over the floor of the geosyncline.

In the Gordon Lake area, the early rifts "tapped" undifferentiated basaltic magma, later flows a magma chamber differentiated to an andesitic composition. Final product of the chamber was a rhyolitic magma.

Some of the basaltic and andesitic flows of the map-area show excellent pillow structure whereas in others this structure is wanting and the rock assumes a massive character. The reason for this is obscure but the answer is probably linked with the conditions under which the lava was extruded.

In his article on "Submarine Pillow Lavas of Southeastern Alaska", A.F. Buddington (1926) makes the following statement.

> "Pillow lavas are of widespread occurrence in the formations of the Lower and Middle Ordovician, Middle and Upper Devonian, Permian, Upper Triassic, and to a minor extent of the Upper Silurian in Southeastern Alaska. Evidence shows that they all originated under submarine conditions. Tertiary volcanics are present in large volume, but were formed under subaerial conditions and show practically no pillow lavas. These data all support the hypothesis that pillow lavas, where developed in quantity over a wide area, are of subaqueous origin".

Since the qualifying conditions are met, the pillow lava flows of the Cameron River volcanic belt are probably due to subaqueous conditions while those in which pillow structure is wanting may be attributed to extrusion under subaerial conditions.

Flow breccia is a common structure in the dacite and rhyolite flows. The formation of flow breccias rather than massive or pillowed types is attributed to their higher silica content, hence more viscous nature. A non-elastic skin quickly forms on these lavas after eruption. This skin continually breaks up as the lava flows along and becomes incorporated within the liquid portion. This process continues until the whole mass consists of angular fragments in a viscous matrix which finally congeals. The angular fragments may consist in part of pyroclastic material blown from the walls of fissures and scattered over the top of the flow.

Tuffs and agglomerates are formed by intermittent explosive action that takes place in a volcanic eruption. This produces a fragmental type of igneous material (Tyrrell, 1941, p.15). In the Cameron River volcanic belt the fragmental rocks occur between unlike lava flows or, not uncommonly, within thick masses of more or less similar flow rock. The pyroclastics generally are lenticular, a reflection of environment of deposition. The pyroclastic material probably accumulated on an undulating surface and subsequent aerial or aqueous transportation agents redeposited the material in localized depressions. The presence of laminated bedding in some of the finer tuffaceous material indicates a water-lain deposit.

Pyroclastic beds may be contaminated by sands and muds of sedimentary origin which are co-deposited with the volcanic material (Tyrrell 1941, p.15). Contamination of this sort probably accounts for the high (up to 50%) biotite content of a number of tuffaceous and agglomeratic rocks.

Some tuff beds (thin section E 3) have a cherty appearance due to partial replacement of feldspar by silica bearing hydrothermal solutions.

Sills of gabbro and diorite have extensively intruded the volcanic assemblage east of Cameron River. The mechanics of intrusion is a subject of speculation but they possibly originated in the following manner. During lulls between active lava eruption, fissures containing fluid magma were sealed off near surface by plugs of congealed material of the same composition. Under these conditions, sufficient increase in pressure from below caused bodily injection of magma along cleavable horizons, without rupturing the surface covering. Magma followed agglomerate or tuff bands laterally from fissures until these beds terminated or the magma became too viscous to flow. Thus only tuff and agglomerate lenses that are transected by fissures of this type are subject to sill intrusions.

Remnants of agglomerate or tuff beds are present in a number of places along contacts of sills in the map-area, thus substantiating the preceding hypothesis.

Because only remnants of these beds remain, a considerable portion of the pyroclastic material has probably been assimilated by the intrusive sills.

Although sills may have been injected at a number of times during the long period of vulcanism, their compositions are similar to the basalt and andesite flows, so that their age, for the main part, antidates the period of dacite flows.

The volcanic rocks and intercalated sills east of Cameron River have been regionally metamorphosed in the manner described in the introductory chapter. As the granodiorite contact is approached from the western part of the volcanic belt, there is a progressive change from low to high grade metamorphism.

In the rocks of basic to intermediate composition the low grade schists do not contain hornblende and are chiefly the products of dissociation of primary pyroxene and feldspar -- chlorite, epidote, and lawsonite (thin section E 7). With this mineral composition, the rock is in a metamorphic zone equivalent to the chlorite zone of the pelitic sediments.

Increasing grade of metamorphism is brought about by development of hornblende (or actinolite) at the expense of chlorite and other early dissociation products (thin sections E 4, E 17, E 5, E 15). The hornblende in the lower grades of metamorphism forms only a minor constituent of the rock; ultimately, in the

higher grades, it becomes the dominant ferromagnesian mineral, and chlorite disappears altogether. The effect of this change is shown graphically on the isograd map (fig. 1).

The isograd curves were drawn to fit data obtained by study of rock thin sections. For each thin section, the hornblende content was divided by the combined amounts of hornblende and chlorite. This ratio, expressed as percentage hornblende, was plotted on the map. The isograd curves were drawn by interpolation.

An apparent exception to the general picture is the presence of chlorite in a flow located about one thousand feet east of Murphy Lake (thin section E 22). Because of its orientation, this slide does not exhibit the schistose nature of the rock. The presence of chlorite is interpreted as being due to partial retrograde metamorphism of the hornblende within a local zone of shearing. The retrograde effect of shearing action upon rocks of high metamorphic grade is discussed at some length by Turner (1948, pp. 299-304).

With reference to the isograds (plate V), the zone of mixed hornblende and chlorite (area between curves 1 and 3) corresponds to the upper part of the chlorite zone and the biotite zone of pelitic sediments. The outer limit of the almandine zone of pelitic sediments is represented by curve "3". In the zone between curve "3" and the granodiorite contact, there is

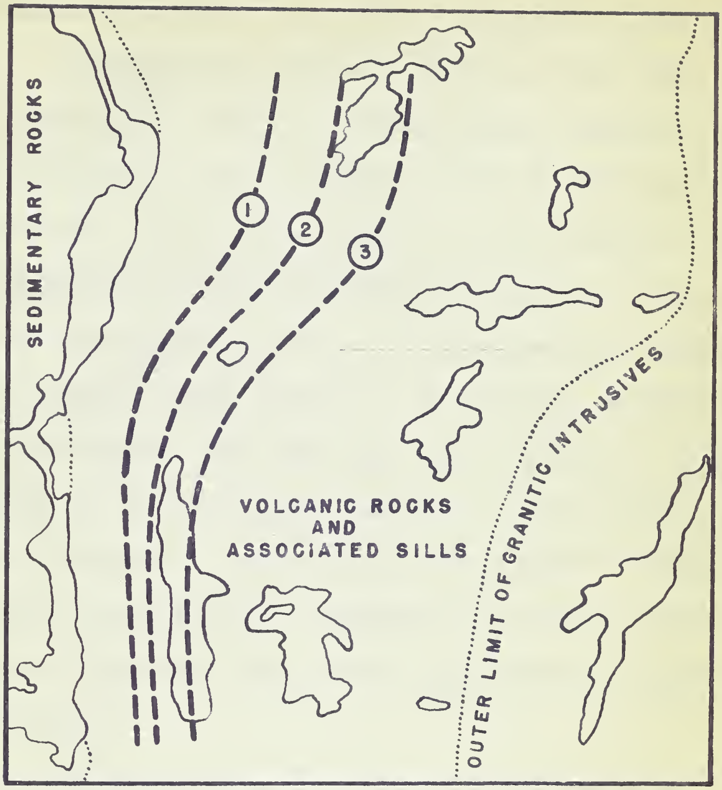


Fig. 1 Metamorphic isograds in the Cameron River volcanic belt as shown by ratio of hornblende to combined hornblende and chlorite.

Curve 1 - 0% hornblende
Curve 2 - 50% hornblende
Curve 3 - 100% hornblende

supposedly a gradual increase in metamorphic grade (staurolite, kyanite, and silimanite grades of pelitic sediments). However, in these rocks the only evidence of higher grade of metamorphism is an increase in grain size, since hornblende is stable throughout this zone.

Although no chemical analyses were made a rough calculation from the mineralogical content indicates that the andesitic and basaltic rocks of the map-area are high in soda. This indicates that they belong to the spilitic kindred, which according to Tyrrell (1941, p.130), form the characteristic lavas of geosynclinal deposition. However, Turner (1948 p.124) in a complete review of the subject concludes that the high soda content of spilites is not due to the original character of the magma. He presents evidence to show that development of albite in spilites is essentially a metasomatic process involving addition of Na_2O and SiO_2 with complementary removal of CaO and Al_2O_3.

In discussing the cause of metamorphism of the rocks of the Cameron River volcanic belt, attention should be drawn to the fact that the granodiorite intrusions shown on the map-area (plate II) represent only the contact zone of a huge batholithic mass to the east.. As shown on plate V, the isograd curves are roughly parallel to the outer limit of the granodiorite intrusions. Because of this, the metamorphism is attributed chiefly to heat and emanations derived from the granodiorite magma.

Further substantiation of this hypothesis may be derived from an inspection of the chemical analysis of a sample of granodiorite (fig. 2). This analysis indicates a relatively high soda content (4.48% Na_2O) as compared to normal granodiorites (3.29% Na_2O). If it is assumed that emanations were given off from this magma, then it should not be surprising to find that they were of a sodic nature. This accounts for the spilitic character of the rocks of the volcanic belt and agrees with Turner's concept of spilite formation.

A thin section (E 8) of rhyolite exhibits the characteristic metamorphism of rocks of acid composition. Although primary orthoclase has not completely broken down to sericite, the metamorphic grade probably corresponds to the biotite zone of pelitic sediments, for the rock contains over 20% biotite.

POST YELLOWKNIFE GRANITIC INTRUSIVES

Field Occurrence and Microscopic Description

Granodiorite (4) - The eastern part of the map (plate II) represents the contact zone of the volcanic rocks and a large granodiorite batholith to the east. Granodiorite dykes are very numerous in the contact zone. Most of the dykes are less than fifty feet wide and may be followed for only a few hundred feet. The dykes typically have an irregular shape so that when represented on a geological map they have a wormy appearance (plate II).

The granodiorite is a coarse grained massive rock which weathers light-grey. The rock contains an appreciable percentage of biotite which not uncommonly has a parallel orientation, giving the rock a gneissic appearance.

In thin section, large crystals of sodaclase (bent) and quartz (sutured) occur in a matrix consisting of sericite, biotite, and crushed feldspar. This is mortar structure.

Chemical analysis of this rock was made at the University of Minnesota by E. H. Kane. Calculations of the norm were made from the analysis and corrected to volumetric percentages. The mode was determined by

Rosiwal measurements of four thin sections. Results are shown in Figure 2.

FIGURE 2

Chemical Analysis, Norm & Mode of Sodaclase Granodiorite

Eileen H. Kane, Analyst
University of Minnesota

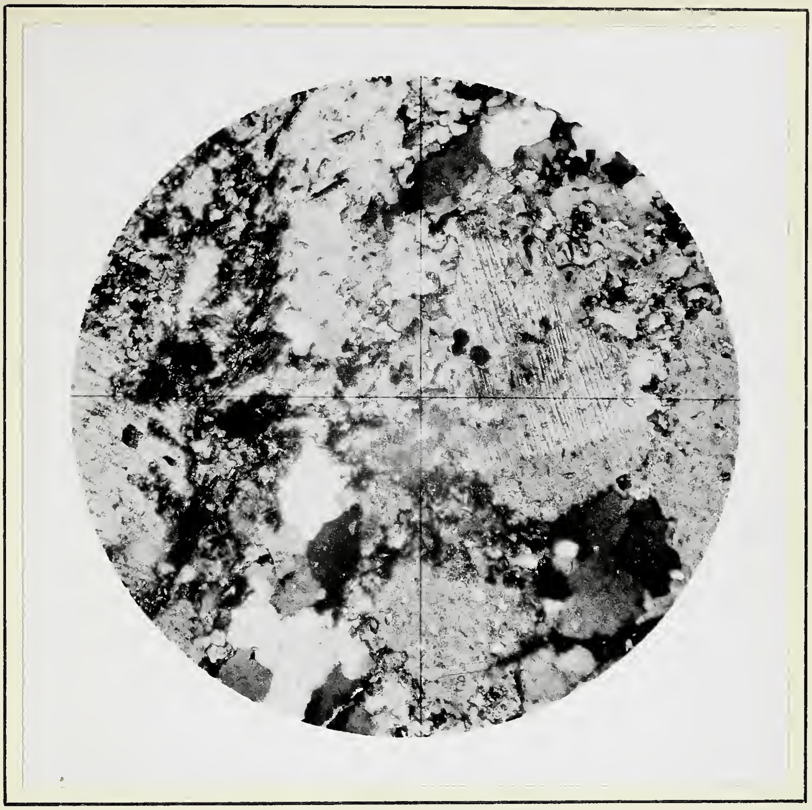
		Norm		
		Q	29.40	
		or	16.87	
SiO_2	71.15	ab	38.20	
Al_2O_3	14.92	an	5.90	
Fe_2O_3	.31	C	2.38	C.I.P.W.
FeO	1.99	hy	5.46	symbol
MgO	1.02	mt	0.47	I.4.2.4
CaO	1.70	ap	0.19	
Na_2O	4.48	cc	0.83	
K_2O	2.79	Total	99.70	
H_2O +	.68			
H_2O -	.04	**Mode**		
CO_2	.30	Sodaclase (Ab_{92})		47.9
T_1O_2	.28	Potash Feldspar		9.5
P_2O_5	.08	Quartz		29.1
MnO	.05	Biotite		7.8
Total	99.79	Sericite		5.5
		Chlorite		0.2
		Total		100.0

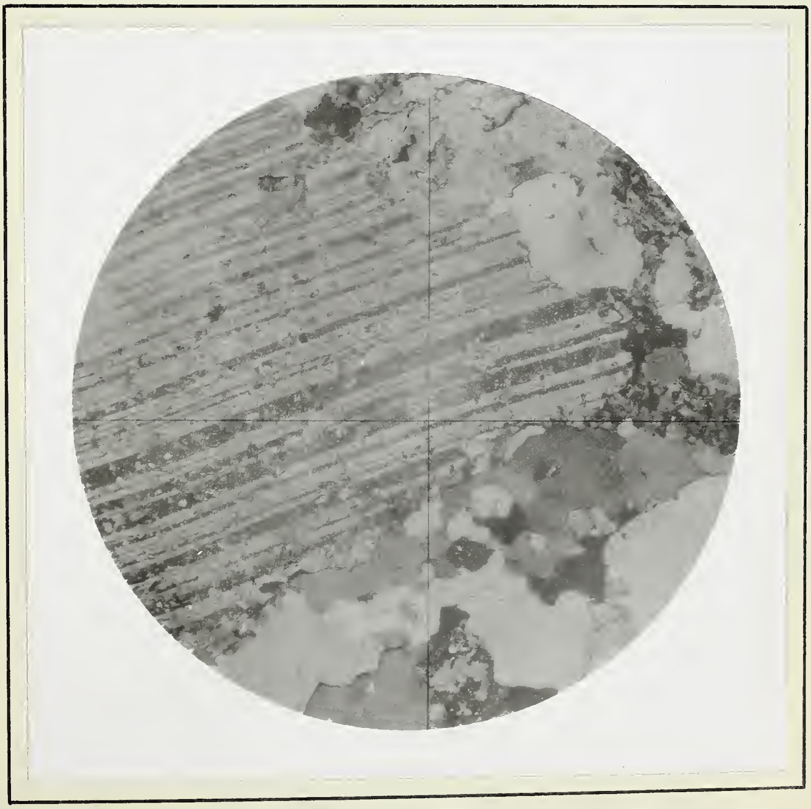
PLATE XII

Granodiorite (4), thin section E 1, crossed nicols, X 60.

The rock is a sodaclase-granodiorite composed chiefly of sodaclase (clouded, in part showing multiple albite twinning) and quartz (clear) with minor biotite (dark). The slide exhibits mortar structure.

As above, different part of thin section. The slide shows a large bent crystal of sodaclase with multiple albite twinning and aggregates of quartz crystals showing sutured contacts.





Granodiorite porphyry (4) - A dyke of this rock occurs in the extreme northern part of the map-area. It is not shown on plate II. The dyke is about fifteen feet wide and outcrops intermittently for a distance of several hundred feet. It strikes almost due west and the dip is steep to vertical.

The rock is uniformly massive and weathers light pinkish-grey. Phenocrysts, about one millimeter in size, occur in a fine grained groundmass. The porphyritic texture however, is not particularly evident in the hand specimen.

In thin section, the mineral constituents are chiefly sodaclase and quartz with minor amounts of potash feldspar, sericite and biotite in decreasing order of abundance. The phenocrysts are sodaclase and comprise ten percent of the rock.

Muscovite-biotite granite - The nearest granite of this type outcrops about four miles southeast of the map-area (plate I), and is mentioned only because of its possible significance to economic geology and metamorphism.

According to Henderson, (1941) the granite is a medium to rather fine grained, pink weathering rock composed of quartz, microcline, orthoclase, oligoclase, biotite and muscovite. Dykes and irregular offshoots of this granite cut the older granodiorite.

Since two granites are present, the younger is probably Proterzoic, the older Archean (Henderson 1948 p.48).

Petrogenesis

In the following discussion, the term granite includes all types of granitic rocks including granodiorite.

There are two schools of thought regarding the origin of granite. One, the magmatic, maintains that granite magmas became primarily molten at great depths within the earth, and rose to their present positions by pushing aside or stoping away the country rocks; and that vapours from this cooling magma have caused the alterations in the neighboring rocks that are grouped collectively under the name "granitization".

The other school has come, by a succession of evolutionary steps, to the present view that granite bodies have originated essentially in their present positions, by the action of "emanations" on the original country rocks; and that only under somewhat unusual and special circumstances have small - relatively small - parts of these granitized masses become fluid, able to act like intrusive magma.

With reference to the magmatic theory, it is a well known fact that enormous volumes of batholithic rocks are commonly found only in mountainous or orogenic areas. These batholiths are believed to have formed at a higher level than basic volcanic rocks; possibly the orogeny pushed down a portion of sial into hotter zones. Upward penetration of magma took place slowly, throughout wide zones, and was accompanied by a wave of granitization and migmatization of the country rocks.

The process of granitization is considered to have proceeded as follows: emanations consisting mainly of Ca and Na ions arise from a deep source into pre-existing sedimentary, volcanic, or intrusive rocks. These ions enter into combination with the silica and other elements already present, forming feldspar and the other constituents of granite, and drive out all ions in excess of the amounts needed for forming granite. This expulsion is just as essential a part of granitization as the introduction of materials. There is little or no change in volume during granitization, hence for every volume introduced another must be driven out.

The entering ions of lime and soda thus sweep ahead of them all ions not needed to form granite; in the main, these will be basic ions, such as iron and magnesia. These, therefore, travel ahead of the centre of granitization, for distances corresponding to their size and mobility. Becoming fixed in their turn, they

will form, at a greater or smaller distance from the centre, a zone of rocks more basic than the pre-existing country rocks. If these happened to have been basic types like andesites or basalts, the basified aureole may become very prominent, and include types as basic as peridotite or hornblendite. A particular characteristic of rocks thus basified is their high content of titanium, phosphorous, or manganese, making them unusually rich in titanite, rutile, and apatite (Cooke, 1948 pp.34-36).

Although the author does not deny the possibility of granitization under certain circumstances, there is no evidence of this process within the map-area. Contrary to the granitization hypothesis, there are indications of a sodic aureole around the granitic mass east of Cameron River, rather than a basified zone. Besides, there is no unusual concentration of titanite, rutile or apatite in the metamorphosed rocks.

Metamorphism of the rocks of the Cameron River volcanic belt must necessarily have been accomplished only by a tremendous amount of heat. If, as the granitization theorists claim, the large granite batholith east of the map-area was never in a magmatic state, it is difficult to conceive how such a large volume of volcanic rock was raised to the hornblende grade of metamorphism. The above discussion indicates that the granitization hypothesis is not applicable in this instance.

On the other hand, there are no serious objections to the magmatic theory of origin for the granodiorite batholith east of the map-area. The steeply dipping volcanic rocks southeast of Gordon Lake indicate that this area was part of an orogenic belt. The orogeny was responsible for folding down a huge synclincrum which extends many miles to the west of the map-area, (plate I). Volcanic rocks, forming the basal section of the stratigraphic column, outcrop along the eastern margin of the synclinorum.

Within the map-area, there is undisputed evidence of magma intrusion in the form of dykes. Magma was injected into fissures and the irregular form of these intrusives is attributed to minor folding of both the dykes and host rock while they were still in a plastic state.

LATE BASIC DYKES

Field Occurrence and Microscopic Description

Diabase (5) - Coarse grained rusty brown weathering diabase dykes, probably of Proterozoic age (Henderson 1939), occur in the southwestern and in the northern extremities of the map-area. They do not outcrop within the area mapped but are shown on map 645A, Gordon Lake South

PLATE XIII

Diabase (5), thin section E 25,

crossed nicols, X 60.

The rock is a normal (olivene) augite-diabase showing typical ophitic texture. Lath-like crystals of labradorite (light) showing multiple albite twinning are imbedded in pyroxene (dark). Scattered crystals of magnetite (black) also occur in the slide.

(plate I). The dykes are about fifty feet wide and strike in a northwesterly direction.

Under the microscope, the dykes appear to be of two distinct types. A thin section of diabase from the southwest part of the map-area shows the chief mineral constituents to be labradorite and augite with minor magnetite and some olivene. The chief minerals of the dyke rock from the northern part of the map-area are andesine, augite and a minor amount of magnetite without olivene. Both rocks however, exhibit similar ophitic textures.

Basalt Porphyry (5) - The only intrusive of this type was found about one hundred feet north of the large bay on the east shore of Murphy Lake. It is actually only a minor occurrence but it attracted the authors attention because of its unusual appearance. The width and exposed length of the dyke are approximately three feet and two hundred feet respectively. The intrusive strikes in a westerly direction and dips at a low angle to the north.

In appearance, the rock is massive and fine grained and weathers brownish-grey. Microscopically, it consists of andesine 45%, augite 35%, magnetite 19% and olivene 1%. Because the constituent minerals are relatively unaltered, the rock is classed with the late basic intrusives. The texture of the rock is porphyritic

with augite phenocrysts occurring in a fine grained intergrowth of andesine and magnetite. The rock contains small scattered amygdules consisting of aggregates of carbonate and quartz. Because of the high magnetite content and the amydaloidal structure, this rock is an unusual type of dyke rock.

Petrogenesis

According to Moore (1944, p.256), the Keeweenawan formations in Canada may be arranged as follows from oldest at the bottom to youngest at the top.

Keeweenawan	Gabbro
	Quartz diabase, norite and diorite (nipissing, Sudbury, etc.)
	Interbedded lavas and sediments
	Killarney granite
	Logan sills
	Olivene diabase

It is recognized that the above table has only general application to the late intrusives of the Canadian Shield, but strangely enough the late basic dykes of the map-area seem to fit this pattern of events. Although the intrusive relationship between the two types of dykes is not known, their relative alteration indicates that the diabase in the northern extremity

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

of the map-area is the older (dyke not shown on plate II). This dyke is made up largely of andesine (Ab_{64}) and augite and contains no olivene (thin section E 26). The andesine is considerably saussuritised. From its composition, this rock corresponds to group (2) of Moore(s classification, (quartz-diabase, norite, and diorite).

In comparison, the other diabase dyke which outcrops in the southwest part of the map-area (also not shown on plate II) is relatively unaltered and appears much younger. This dyke consists chiefly of labradorite Ab_{32} and augite and carries a small amount of olivene (thin section E 25). This dyke corresponds to group (6) of Moore's classification (olivene-diabase).

It is not the intention of the author to correlate the ages of the diabase dykes with Moore's table. It does seem interesting however, that on the Canadian Shield, the younger diabase is generally more basic than the older. Insofar as this thesis is concerned, the age of the diabase in the map-area is considered simply as Proterozoic as shown on Henderson's map, Gordon Lake South (plate I).

With regard to the origin of the late diabase dykes, their widespread occurrence in the Northwest Territories and elsewhare on the Canadian Shield, suggests that they were not formed in extension joints due to orogenic compression. There are comparatively few places on the Canadian Shield where there is evidence of orogenic

compression in late Precambrian time. The formation of these dykes is attributed to tensional fractures which extended down to the simatic layer of the earth's crust. This probably resulted in great lava flows of the plateau basalt type spreading over areas of the Canadian Shield. Such lava flows, if they did form in this manner, have largely been stripped from the shield except in local areas where orogenic folding (or down faulting) has preserved them from erosion.

III STRUCTURAL AND ECONOMIC GEOLOGY

GENERAL STATEMENT

In a number of places in the map-area, field mapping indicated small displacements in the continuity of marker beds. In the majority of cases, these displacements were not considered as justification for assuming the existence of faults; such displacement could be due to slight warping or to differences in elevation of steeply dipping beds. Consequently definite evidence of faulting was present in only two places within the map-area (plate II).

As a rule, the volcanic rocks are not subject to intricate folding. However, minor crenulations occur in the eastern part of the map-area, within the contact zone of the granodiorite batholith. Elsewhere, only broad flexures are present.

Most of the known gold-bearing deposits of the map-area occur in shear zones but several consist of mineralized quartz veins. The shear zones are generally represented on surface by north striking linear depressions and outcrops of the shear zones are rare. Where

exposed, the shear zones occur within relatively incompetent pyroclastic beds which also trend north. There is a possibility that some of the shear zones are not confined to pyroclastic beds down dip. This factor could have an important bearing on ore deposition.

The mineralized quartz veins are of the fissure filling type. The walls of the veins are not sheared and the veins have not been found in pyroclastic beds but rather in massive recrystallized greenstone (1a) and granodiorite (4).

A detailed description of the important mineral deposits follows.

FRANK VEIN

The Frank Vein, which outcrops in the eastern part of the map-area, (plate II) strikes north 25 degrees east and dips about 70 degrees east. It is a bluish-grey quartz vein which has an exposed length of 130 feet, and width varying from 3 to 6 feet. The vein appears to diagonally transect a granodiorite dyke although silicification of the wall rock makes it difficult to identify contacts. Because the vein cuts the granodiorite, there is a good possibility that the vein minerals are directly related to the younger granite exposed about four miles to the southeast (plate I).

PLATE XIV

FRANK VEIN

The picture was taken a few days after the discovery of the Frank vein, May 1947 and before trenching or stripping. The vein-quartz (light) is easily distinguished from the greenstone country rock (dark). Visible gold occurs at a number of places along the vein.

Arsenopyrite is the commonest sulphide present in the vein, chalcopyrite occurs in lesser amounts. Native gold, coarse enough to be seen by the unaided eye, occurs in many parts of the vein.

A number of trenches were blasted in the vein at close intervals to provide fresh surfaces for sampling. Sampling indicated an average grade of 0.36 ounces gold per ton for a length of 115 feet and an average width of 4.2 feet.

Eight shallow diamond drill holes proved the downward extension of the vein to a depth of 45 feet. Assays of drill core intersections were similar to surface sampling results.

MURPHY ZONE

The Murphy Zone outcrops about 1,000 feet northeast of Murphy Lake and extends north along a muskeg filled depression. Where exposed, the zone is about 300 feet wide. The Murphy Zone consists of schistose agglomerate and tuff containing bodies of white quartz and carbonate up to twenty feet wide. The schistose material is well mineralized and is marked on surface by a gossan layer several feet thick. Small amounts of fine gold may be panned at intervals across the entire width of the zone.

The quartz-carbonate bodies, which probably constitute a third of the volume of the zone, have a slight rusty appearance.

The zone was diamond drilled and a fairly complete core was obtained across the section. Schistose bands are highly impregnated with arsenopyrite but quartz-carbonate bodies are practically barren of mineralization. Most of the core assayed trace of gold. However, a section of core 8 feet long and another 3 feet long assayed 0.06 ounces per ton. Another section, 1.5 feet long, assayed 0.09 ounces gold per ton.

MER ZONE

The Mer Zone outcrops 1,300 feet due east of the centre of Murphy Lake (plate II). The Zone consists of a sheared basic tuff band, about ten feet wide, between a massive flow on the east and a porphyritic pillow lava on the west. Small lenses of quartz are present and where exposed probably constitute fifty per-cent of the zone. The quartz is well mineralized with arsenopyrite and some gold but the schistose material is only slightly mineralized. The zone was traced 2,000 feet northward on strike by intermittently spaced diamond drill holes. Several narrow sections assayed from 0.03 to 0.09

ounces gold per ton. One section, near the southern exposure, assayed 0.58 ounces gold per ton for a core length of one foot.

CAM ZONE

The Cam Zone outcrops 200 feet southeast of the camp on Murphy Lake. The zone strikes north and follows the contact between a cherty tuff band on the west and a massive lava flow on the east. Three drill holes intersected the zone at intervals of approximately 400 feet along strike. Drill core intersections of the zone consisted of sheared tuffaceous rock with well mineralized quartz stringers. Both pyrite and arsenopyrite were present in the stringers. A one foot core section from the most southerly hole assayed 0.17 ounces gold per ton and a similar assay was obtained from a drill hole about four hundred feet north.

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V APPENDIX A

PETROGRAPHIC DESCRIPTION OF THIN SECTIONS

Colors of hand specimens were determined by comparison with a rock color chart based on the Munsell system of color identification. This type of chart is distributed by the National Research Council, Washington, D.C. The Munsell numerical designations are given for both the fresh and weathered rock surfaces.

The composition of the feldspars was determined by immersion in an oil of known refractive index. A standard set of immersion oils was made up of various proportions of medium-government oil and halowax oil. The set consisted of thirteen oil mixtures with index intervals of 0.005, covering the complete range of the feldspars from 1.520 to 1.580. The index of the oil mixtures was determined with an abbey refractometer using sodium vapour light. The work was carried out at a room temperature of 24°C ± 1°. Determination of the composition of the plagioclase feldspar by this method is estimated to have a maximum possible error of ± 2% albite.

In classifying the metamorphic rocks, the terminology is based on that used by A. Harker. In the case of igneous rocks, reference was made to the terminology used by both F. Grout and A. Johannsen.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

e Collected September 1947
lector R. W. Edie

Specimen No. E 1
Locality Cameron River
Reference Volcanic Belt N.W.T.

FIELD NOTES
Occurrence: DYKE (offshoot from batholith)
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. medium grey w.s. light grey
Grain size: coarse 3-5 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. N5
w.s. N7

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: granitic
Structure: original massive secondary mortar structure

'RIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
;ssential		Alteration products (z)			
odaclase	50	sericite	2.5		
otash feldspar	11	kaolinite	< 0.5		
uartz	24	chlorite	< 0.5		
		leucoxene	0.5		
'arietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
iotite	11	mortar consists of sericite, biotite and crushed feldspar		carbonate	
ccessory (y)					
patite	< 0.5				

:CIAL FEATURES:

Sodaclase: composition Ab_{92}; euhedral to subhedral form; somewhat altered to ericite; maximum extinction angle from zone at right angles to 010 = 13°; extinction ngle in section normal to B.X.A. from Z to 010 = 11°; indices Ng = 1.541, Np = 1.532

ASSIFICATION Biotite - Sodaclase - Granodiorite

PETROGRAPHER
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PETROGRAPHIC DESCRIPTION

te Collected September 1947
lector R. W. Edie

Specimen No. E 2
Locality Cameron River
Reference Volcanic Belt N.W.T.

FIELD NOTES
Occurrence: dyke
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. medium grey w.s. light pinkish grey
Grain size: phenocrysts 1 mm. in fine grained groundmass
Texture: porphyritic
Alteration:

Munsell No.
f.s. N5
w.s. 5YR7/1

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: porphyritic
Structure: original massive secondary none developed

RIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
ssential		Alteration products (z)			
odaclase	50	sericite	7		
otash feldspar	10	kaolinite	1		
uartz	25	leucoxene	1		
'arietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
iotite	6	felted intergrowth of feldspar, quartz, biotite, sericite etc. - 90% of rock		carbonate	
ccessory (y)					
patite	< 1				
lmenite	< 1				

CIAL FEATURES:

Sodaclase: composition Ab_{91}; considerably altered to sericite and kaolinite; ndices Ng = 1.542, Np = 1.533.

Phenocrysts - sodaclase - 10% of rock

SSIFICATION Biotite - Sodaclase - Granodiorite Porphyry

PETROGRAPHER
R. W. Edie

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

te Collected September 1947
lector R. W. Edie

Specimen No. E 3
Locality Cameron River
Reference Volcanic Belt
N.W.T.

FIELD NOTES
Occurrence: banded tuff bed
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. dark grey w.s. light olive grey
Grain size: fine grained
Texture: equigranular
Alteration:

Munsell No.
f.s. N3
w.s. 5Y6/1

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original stratified secondary slightly schistose

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
		leucoxene	2	mica	45
		hematite	< 1	andesine	15
				quartz	8
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		fine grained intergrowth of andesine, quartz and mica		quartz	30
ilmenite	< 1			pyrrhotite	

ECIAL FEATURES:

Andesine: composition Ab_{60}; indices Ng = 1.557, Np = 1.550.

Mica; appears to vary in composition from pale green sericite through to greenish-grey to reddish-brown biotite.

The rock appears to be highly silicified. In certain areas, the feldspar has been completely replaced by quartz.

The term crystalloblastic refers to a completely recrystallized texture which is non porphyritic.

ASSIFICATION Altered Acid Tuff (Quartz - Biotite - Schist)

PETROGRAPHER
R. W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ate Collected September 1947
ollector R. W. Edie

Specimen No. E 4
Locality Cameron River
Reference Volcanic Belt N.W.T.

I. FIELD NOTES
Occurrence: flow breccia
Question:

I. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. light olive grey to greenish grey
Grain size: medium grained ½-2 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 5Y6/1 to 5GY6/1

I. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original vesicular secondary schistose

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		andesine	50
		leucoxene	1	quartz	5
				chlorite	20
				actinolite	5
				clinozoisite	2
Varietal (x)				biotite	<1
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		chiefly fine grained andesine with numerous poikilitic inclusions of chlorite		carbonate - trace	
ilmenite	2			hematite - trace	
apatite	<1				
titanite	<1				

PECIAL FEATURES:

Andesine: composition Ab_{63}; anhedral form; indices - Ng = 1.556, Np = 1.448.

Actinolite: fibrous inclusions in lenticular quartz amygdules; pleochroism light olive green to pale green; Z on C = 17°.

Clinozoisite: radial aggregates; some sections show abnormal blue interference color.

LASSIFICATION Altered Dacite (Andesine - Quartz - Chlorite - Schist)

PETROGRAPHER
R. W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ate Collected September 1947
ollector R. W. Edie

Specimen No. E 5
Locality Cameron River
Reference Volcanic Belt N.W.T.

I. FIELD NOTES
Occurrence: pillowed lava flow
Question:

I. HAND SPECIMEN DESCRIPTION
Color: f.s. medium dark grey w.s. light olive grey
Grain size: medium grained ½-2 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. N4
w.s. 10Y5/1

I. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: porphyroblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		oligoclase	45
		leucoxene	1	hornblende	30
				chlorite	15
				biotite	4
Varietal (x)				clinozoisite	<1
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		chiefly fine grained oligoclase with poikilitic inclusions of chlorite		quartz	
ilmenite	5				

SPECIAL FEATURES:

Oligoclase: composition Ab_{81}; anhedral form; indices Ng = 1.545, Np = 1.538.

Hornblende: porphyroblasts: euhedral form; Z on C = 18°; pleochroism X = yellowish-green; Y = olive green, Z = bluish green.

CLASSIFICATION Altered Andesite (Oligoclase - Amphibolite)

PETROGRAPHER
R. W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

te Collected September 1947
lector R. W. Edie

Specimen No. E 6
Locality Cameron River
Reference Volcanic Belt
N.W.T.

FIELD NOTES
Occurrence: pillowed lava flow
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. greenish grey
Grain size: fine grained 1 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 5GY6/1

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary slightly schistose

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
		leucoxene	< 1	oligoclase	55
		hematite		hornblende	35
				biotite	2
				chlorite	1
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
quartz	3	fine grained oligoclase		pyrrhotite	< 1
Accessory (y)				carbonate	< 1
ilmenite	4				
apatite	< 1				

'ECIAL FEATURES:

Oligoclase: composition Ab_{71}; anhedral form; indices Ng = 1.551, Np = 1.544.

Hornblende: euhedral form; Z on C = 17°; pleochroism X = yellowish-green, Y = olive-green, Z = bluish-green.

Quartz: occurs as amygdules with fibrous inclusions of hornblende.

LASSIFICATION Altered Andesite (Oligoclase - Amphibolite)

PETROGRAPHER
R. W. Edie

UNIVERSITY OF ALBERTA
DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

e Collected September 1947
lector R. W. Edie

Specimen No. E 7
Locality Cameron River
Reference Volcanic Belt
N.W.T.

FIELD NOTES
Occurrence: massive lava flow
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. medium dark grey w.s. moderate yellowish-brown
Grain size: fine grained 1 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. N4
w.s. 10YR5/4

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		lawsonite	20
		leucoxene	<1	andesine	35
				chlorite	20
				epidote	15
Varietal (x)				quartz	7
				biotite	<1
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		chiefly fine grained andesine with numerous inclusions of lawsonite, chlorite and epidote		quartz	
ilmenite	3			carbonate	
				orthoclase	
				apatite	
				titanite	
				chlorite	
				ilmenite	

ECIAL FEATURES:

Andesine: composition Ab_{68}; anhedral form; indices - Ng = 1.553, Np = 1.546

Original feldspar and ferromagnesian minerals have been saussuritized and chloritized.

Lawsonite: composition $H_4CaAl_2Si_2O_{10}$; identified on the basis of relief, birefringence and association.

LASSIFICATION Altered Andesite (Andesine - Chlorite - Epidote - Hornfels)

PETROGRAPHER
R. W. Edie

UNIVERSITY OF ALBERTA
DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

te Collected September 1947
lector R. W. Edie

Specimen No. E 8
Locality Cameron River
Reference Volcanic Belt N.W.T.

FIELD NOTES
Occurrence: lava flow
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. medium grey w.s. yellowish grey to light greenish grey
Grain size: fine grained 1 mm.
Texture: equigranular
Alteration:

Munsell No.
f.s. N5
w.s. 5Y7/1 to 5GY7/1

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary slightly schistose

PRIMARY MINERALS	%	SECONDARY MINERALS Alteration products (z)	%	METAMORPHIC MINERALS	%
Essential					
orthoclase	9	leucoxene	<1	mica	50
quartz	40			epidote	1
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		chiefly fine grained intergrowth of quartz and minor amount of orthoclase		carbonate	

PECIAL FEATURES:

Mica: varies from pale green sericite through to greenish-grey to reddish-brown biotite; dense aggregates of sericite are probably psuedomorphs after original phenocrysts of orthoclase.

LASSIFICATION Altered Rhyolite (Quartz - Biotite - Sericite - Schist)

PETROGRAPHER
R. W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

e Collected September 1947
lector R. W. Edie

Specimen No. E 9
Locality Cameron River
Reference Volcanic Belt N.W.T.

FIELD NOTES
Occurrence: tuff bed
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. medium dark grey w.s. greyish olive-green
Grain size: fine grained 1 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. N4
w.s. 5GY3/2

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary slightly schistose

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
		leucoxene	<1	hornblende	60
				andesine	20
				quartz	14
Varietal (x)				biotite	<1
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		fine grained intergrowth of quartz and andesine		carbonate pyrrohotite	
ilmenite	6				

PECIAL FEATURES:

Andesine: composition Ab_{53}; anhedral form; indices Ng = 1.561, Np = 1.553.

Hornblende: euhedral to subhedral form; Z on C = 19°
pleochroism X = yellowish-green, Y = olive-green, Z = bluish-green.

CLASSIFICATION Altered Basaltic Tuff (Andesine - Amphibolite)

PETROGRAPHER
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PETROGRAPHIC DESCRIPTION

e Collected September 1947
lector R. W. Edie

Specimen No. E 10
Locality Reference Cameron River Volcanic Belt N.W.T.

FIELD NOTES
Occurrence: tuff bed
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. dark grey w.s. light olive grey
Grain size: fine grained 1 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. N3
w.s. 5Y6/1

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary slightly schistose

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
		leucoxene	< 1	biotite	55
		hematite	< 1	hornblende	7
				labradorite	30
Varietal (x)				quartz	5
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		chiefly fine grained labradorite		carbonate	
				pyrrhotite	
ilmenite	3				

ECIAL FEATURES:

Labradorite: composition Ab_{38}, anhedral form, indices Ng = 1.568, Np = 1.560

The rock appears to have an unusually high percentage of biotite. This probably indicates that the rock was partly or wholly made up of sedimentary material.

LASSIFICATION Altered Greywacke or Tuff (Biotite - Labradorite - Hornfels) PETROGRAPHER R. W. Edie

UNIVERSITY OF ALBERTA
DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

e Collected September 1947
lector R. W. Edie

Specimen No. E 11
Locality Cameron River
Reference Volcanic Belt N.W.T.

FIELD NOTES
Occurrence: agglomerate bed
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. dark greenish grey and moderate brown
Grain size: medium grained ½-2 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 5GY4/1 and 5YR4/4

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary slightly schistose

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
				hornblende	65
				biotite	4
		leucoxene	<1	quartz	18
				labradorite	10
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		fine grained intergrowth of quartz and labradorite		pyrite	
ilmenite	3				

PECIAL FEATURES:

Labradorite: composition Ab_{42}; anhedral form; few crystals show multiple albite twinning; indices Ng = 1.566, Np = 1.558.

Hornblende: euhedral to subhedral form, Z on C = 19½° pleochroism X = yellowish-green, Y = olive-green, Z = bluish-green; brownish smudges within the hornblende represent incipient growth of biotite.

CLASSIFICATION Altered Basaltic Agglomerate (Labradorite - Quartz - Amphibolite)

PETROGRAPHER R. W. Edie

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PETROGRAPHIC DESCRIPTION

te Collected September 1947
llector R. W. Edie

Specimen No. E 12
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: agglomerate bed
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s.
Grain size: fine grained 1 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 5G5/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		hornblende	45
				labradorite	40
				biotite	4
				quartz	5
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		fine grained intergrowth of feldspar and minor amount of quartz			
ilmenite	6				

PECIAL FEATURES:

Labradorite: composition Ab_{48}; anhedral form; indices Ng = 1.564, Np = 1.556.

Hornblende: euhedral to subhedral form; Z on C = 17°; pleochroism X = yellowish-green, Y = olive-green, Z = bluish-green.

CLASSIFICATION Altered Basaltic Agglomerate (Labradorite - Amphibolite)

PETROGRAPHER
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PETROGRAPHIC DESCRIPTION

te Collected September 1947
lector R. W. Edie

Specimen No. E 13
Locality Cameron River
Reference Volcanic Belt
N.W.T.

FIELD NOTES
Occurrence: pillowed lava flow
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. greenish black
Grain size: fine grained 1 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 5GY2/1

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original amygdaloidal secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		hornblende	70
				basic plagioclase	15
				clinozoisite	4
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
quartz	8	fine grained basic plagioclase feldspar			
Accessory (y)					
ilmenite	3				

PECIAL FEATURES:

Basic plagioclase: indices and hence composition was not determined due to numerous inclusions of hornblende in the feldspar.

Hornblende: euhedral to subhedral form; Z on C = 18°; pleochroism X = yellowish-green, Y = olive-green, Z = bluish-green.

Quartz - occurs as amygdules

LASSIFICATION Altered Basalt (Plagioclase - Amphibolite)

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PETROGRAPHIC DESCRIPTION

te Collected September 1947
llector R. W. Edie

Specimen No. E 14
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: massive lava flow or sill
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. dark greenish grey
Grain size: med grained $\frac{1}{2}$-2 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 10GY4/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: palimpsest
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
andesine	15	leucoxene	1	andesine	20
		kaolin	< 1	hornblende	60
				epidote	1
				biotite	2
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
		fine to coarse grained andesine			
Accessory (y)					
ilmenite	2				

PECIAL FEATURES:

Andesine: composition Ab_{58}; indices Ng = 1.558, Np = 1.552; original feldspar has brownish clouded appearance whereas recrystallized feldspar is comparitively clear and much finer grained.

The term palimpsest refers to relict texture, in this case the primary feldspar crystals which still show the original twinning lamellae.

Hornblende: euhedral to subhedral form; Z on C = $20\frac{1}{2}°$ pleochroism X = yellowish-green, Y = olive-green, Z = greenish-blue.

CLASSIFICATION Altered Basalt or Gabbro (Andesine - Amphibolite)

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PETROGRAPHIC DESCRIPTION

te Collected September 1947
lector R. W. Edie

Specimen No. E 15
Locality Cameron River
Reference Volcanic Belt
N.W.T.

FIELD NOTES
Occurrence: porphyritic top of sill
Question:

HAND SPECIMEN DESCRIPTION
Color: f.s. medium dark grey w.s. greyish yellow green
Grain size: phenocrysts up to 10 mm. in fine grained ground mass
Texture: porphyritic
Alteration:

Munsell No.
f.s. N4
w.s. 5GY6/2

MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: blastoporphyritic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
				oligoclase	50
		sericite	1	biotite	17
		kaolin	< 1	chlorite	20
				epidote	1
Varietal (x)					
quartz	3	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		fine grained intergrowth of biotite, chlorite, oligoclase and ilmenite		carbonate	3
				hematite - trace	
ilmenite	5				

PECIAL FEATURES:

Oligoclase: composition Ab_{76}; anhedral form; indices Ng = 1.548, Np = 1.542.

Chlorite and biotite appear as poikilitic inclusions and as fine intergrowths with feldspar.

An amygdule of quartz with a minor amount of carbonate occurs in the slide.

LASSIFICATION Altered Porphyritic Diorite (Chlorite - Biotite - Oligoclase - Hornfels)

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PETROGRAPHIC DESCRIPTION

te Collected September 1947
llector R. W. Edie

Specimen No. E 16
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: massive lava flow or sill
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. dark greenish grey
Grain size: medium grained ½-2 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 5G3/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
		epidote	<1	hornblende	50
				andesine	45
				quartz	1
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
		mostly fine grained andesine		carbonate - trace	
Accessory (y)					
apatite	<1				
ilmenite	4				

PECIAL FEATURES:

Andesine: composition Ab_{67}; anhedral form; indices $N_g = 1.554$, $N_p = 1.546$.

Hornblende: euhedral to subhedral form, Z on C = 21°; pleochroism X = yellowish-green, Y = olive-green, Z = greenish-blue.

CLASSIFICATION Altered Basalt or Gabbro (Andesine - Amphibolite)

PETROGRAPHER
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PETROGRAPHIC DESCRIPTION

ate Collected September 1947
ollector R. W. Edie

Specimen No. E 17
Locality Cameron River
Reference Volcanic Belt
N.W.T.

I. FIELD NOTES
Occurrence: sill
Question:

I. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. greenish grey
Grain size: coarse grained 3-6 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 10 GY3/1
w.s. 10 GY5/1

I. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
		leucoxene	< 1	oligoclase	40
				chlorite	23
				hornblende	17
				epidote	10
Varietal (x)				quartz	4
				biotite	2
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		fine grained intergrowth consisting chiefly of oligoclase, chlorite and epidote		carbonate pyrite	
ilmenite	4				

PECIAL FEATURES:

Oligoclase: composition Ab_{72}; anhedral form; indices Ng = 1.551, Np = 1.544.

Hornblende: euhedral form; Z on C = 18°; pleochroism X = yellowish-green, Y = olive-green, Z = bluish-green.

The original ferromagnesian mineral was altered to chlorite. The chlorite in turn has been only partially recrystallized to hornblende. Hornblende crystals form a definite pattern indicating changing stress conditions during recrystallization.

CLASSIFICATION Altered Diorite (Oligoclase - Amphibolite)

PETROGRAPHER
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PETROGRAPHIC DESCRIPTION

ate Collected September 1947
ollector R. W. Edie

Specimen No. E 18
Locality Cameron River
Reference Volcanic Belt N.W.T.

I. FIELD NOTES
Occurrence: lava flow or sill
Question:

I. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. dark greenish grey
Grain size: medium grained ½-2 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 10GY4/1

I. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary slightly schistose

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		hornblende	70
				oligoclase	25
				quartz	2
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		chiefly fine grained oligoclase		hisingerite (?)	
ilmenite	3				

SPECIAL FEATURES:

Oligoclase: composition Ab_{70}; anhedral form; indices Ng = 1.552, Np = 1.545.

Hornblende: euhedral to subhedral form; Z on C = 19½°; pleochroism X = yellowish-green, Y = olive-green, Z = greenish-blue; hornblende is found as scattered well defined crystal aggregates and as incipient growth in areas of chlorite

CLASSIFICATION Altered Basalt or Gabbro (Oligoclase - Amphibolite)

PETROGRAPHER R. W. Edie

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PETROGRAPHIC DESCRIPTION

ate Collected September 1947
llector R. W. Edie

Specimen No. E 19
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: dyke
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. black & pale orange w.s. brownish black & greyish orange
Grain size: coarse grained 3-5 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. N1 and 10YR8/2
w.s. 5YR2/1 and 10YR7/4

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: palimpsest
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
oligoclase	20	leucoxene	<1	hornblende	50
		kaolin	<1	oligoclase	24
		sericite	<1		
		clinozoisite	<1		
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
		chiefly fine to coarse grained oligoclase		carbonate	
Accessory (y)					
apatite	1				
titanite	1				
ilmenite	4				

PECIAL FEATURES:

Oligoclase: composition Ab_{77}; indices Ng = 1.551, Np = 1.543; section normal to X extinction angle from 010 = 87°; maximum extinction angle in zone at right angles to 010 = 12½°; some of the primary feldspar has been recrystallized to fine grained anhedral aggregates; feldspar crystals do not show uniform extinction, indicates zoning.

Hornblende: contains relict schiller structure after pyroxene; Z on C = 18.5°; pleochroism X = yellowish-green, Y = olive-green, Z = greenish-blue.

LASSIFICATION Altered Gabbro (Oligoclase - Amphibolite)

PETROGRAPHER
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PETROGRAPHIC DESCRIPTION

te Collected September 1947
llector R. W. Edie

Specimen No. E 20
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: sill
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. dusky yellowish green and pinkish grey
Grain size: coarse grained 3-5 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 10GY4/1
w.s. 10GY3/2 and 5YR7/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS %	SECONDARY MINERALS %	METAMORPHIC MINERALS %
Essential	Alteration products (z)	hornblende 35 oligoclase 37 chlorite 20 biotite 8
Varietal (x)	GROUNDMASS OR CEMENT chiefly fine grained oligoclase	MINERALIZATION carbonate
Accessory (y) ilmenite		

PECIAL FEATURES:

Oligoclase: composition Ab_{70}; anhedral form; indices Ng = 1.552, Np = 1.545.

Hornblende: Z on C = 22°; pleochroism X = yellowish-green, Y = olive-green; subhedral to anhedral form.

Both hornblende and biotite appear as incipient growth in areas of chlorite.

LASSIFICATION Altered Diorite (Hornblende - Oligoclase - Chlorite - Hornfels)

PETROGRAPHER
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PETROGRAPHIC DESCRIPTION

te Collected September 1947
llector R. W. Edie

Specimen No. E 21
Locality Cameron River
Reference Volcanic Belt N.W.T.

. FIELD NOTES
Occurrence: pillowed lava flow
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. greenish black
Grain size: fine grained 1 mm.
Texture: equigranular
Alteration:

Munsell No.
f.s. 5GY3/1
w.s. 5GY2/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: blastophitic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		hornblende	35
		epidote	1	chlorite	30
				ologoclase	28
				biotite	< 1
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
		fine grained oligoclase		hisingerite (?)	
Accessory (y)					
ilmenite	6				

PECIAL FEATURES:

Oligoclase: composition Ab_{73}; anhedral form; indices Ng = 1.550, Np = 1.543.

Hornblende; subhedral to anhedral form; Z on C = 18°; pleochroism X = yellowish green, Y = olive-green, Z = bluish-green; hornblende occurs as incipient growth in chlorite.

The rock appears to have a relict ophitic texture (blastophitic)

LASSIFICATION Altered Andesite (Hornblende - Chlorite - Oligoclase - Hornfels)

PETROGRAPHER R. W. Edie

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PETROGRAPHIC DESCRIPTION

ate Collected September 1947
ollector R. W. Edie

Specimen No. E 22
Locality Cameron River
Reference Volcanic Belt N.W.T.

I. FIELD NOTES
Occurrence: pillowed lava flow
Question:

I. HAND SPECIMEN DESCRIPTION
Color: f.s. greyish black w.s. dark greenish grey & pinkish grey
Grain size: phenocrysts up to 4 cm.
Texture: porphyritic
Alteration:

Munsell No.
f.s. N2
w.s. 5G3/1 and 5YR7/1

I. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: blastoporphyritic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)		hornblende	17
				chlorite	30
				oligoclase	50
				biotite	2
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		fairly coarse grained intergrowth consisting chiefly of chlorite, hornblende and oligoclase		hisingerite	
titaniferous magnetite	1				

PECIAL FEATURES:

Oligoclase: composition Ab_{72}; anhedral form; indices Ng = 1.551, Np = 1.543; ggregates of oligoclase psuedomorphic after original plagioclase phenocrysts.

Hornblende; euhedral to subhedral form; Z on C = 23°; pleochroism X = greenish-yellow, Y = medium green, Z = greenish-blue.

CLASSIFICATION Altered Porphyritic Andesite (Oligoclase - Chlorite - Hornblende - Hornfels)

PETROGRAPHER R.W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ate Collected September 1947
llector R. W. Edie

Specimen No. E 23
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: pillowed lava flow
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. greenish-black and pinkish-grey
Grain size: medium grained 1-3 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. 5G3/1
w.s. 5GY2/1 and 5YR7/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
		leucoxene	1	hornblende	50
				andesine	45
Varietal (x)				quartz	∠ 1
				chlorite	1
		GROUNDMASS OR CEMENT		MINERALIZATION	
		fine grained andesine		carbonate	
Accessory (y)					
lmenite	4				
patite	∠ 1				

PECIAL FEATURES:

Andesine: composition Ab_{51}; anhedral form; indices Ng = 1.562, Np = 1.555.

Hornblende: euhedral to subhedral form; Z on C = 19°; pleochroism
 = yellowish-green, Y = olive-green, Z = greenish-blue.

LASSIFICATION Altered Basalt (Andesine - Amphibolite)

PETROGRAPHER
R. W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ite Collected September 1947
llector R. W. Edie

Specimen No. E 24
Locality Cameron River
Reference Volcanic Belt N.W.T.

. FIELD NOTES
Occurrence: lava flow
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark grey w.s. light olive-grey and dark greenish-grey
Grain size: medium grained 1-2 mm.
Texture: inequigranular (serial)
Alteration:

Munsell No.
f.s. N3
w.s. 5Y6/1 and 5GY3/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: crystalloblastic
Structure: original no evidence secondary massive

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
				hornblende	45
		leucoxene	2	oligoclase	35
		hematite	<1	biotite	8
				quartz	5
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)		chiefly fine grained oligoclase with inclusions of biotite		calcite	<1
ilmenite	4			specularite (?)	
apatite	1				

PECIAL FEATURES:

Oligoclase: composition Ab_{71}; anhedral form; indices Ng = 1.551, Np = 1.544.

Hornblende: euhedral to subhedral form; X on C = 22°; pleochroism X = yellowish-green, Y = dark green, Z = greenish-blue.

LASSIFICATION Altered Andesite (Oligoclase - Amphibolite)

PETROGRAPHER
R. W. Edie

UNIVERSITY OF ALBERTA
DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ate Collected September 1947
ollector R. W. Edie

Specimen No. E 25
Locality Cameron River
Reference Volcanic Belt N.W.T.

I. FIELD NOTES
Occurrence: dyke
Question:

I. HAND SPECIMEN DESCRIPTION
Color: f.s. dark grey w.s. moderate yellowish brown & brownish black
Grain size: medium grained 1-3 mm.
Texture: equigranular
Alteration:

Munsell No.
f.s. N3
w.s. 10YR5/4 and 5YR2/1

I. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: ophitic
Structure: original massive secondary none developed

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
labradorite	50	chlorite	3		
augite	35	epidote	1		
		lawsonite	3		
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
olivene		anhedral crystals of augite			
Accessory (y)					
magnetite	7				

PECIAL FEATURES:

Labradorite: composition Ab_{32}; euhedral to subhedral form; extinction angles in the zone at right angles to 010 when the albite twinning is combined with carlsbad twinning L = 17°, R = 37°; indices Ng = 1.570, Np = 1.562.

Augite: Z on C = 47°.

Colorless olivene crystals are found closely associated with magnetite.

CLASSIFICATION Normal Augite diabase

PETROGRAPHER
R. W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ate Collected September 1947
llector R.W. Edie

Specimen No. E 26
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: dyke
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. dark greenish grey w.s. light brown and brownish black
Grain size: medium grained 1-3 mm.
Texture: equigranular
Alteration:

Munsell No.
f.s. 5G4/1
w.s. 5YR5/4 and 5YR2/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: ophitic
Structure: original massive secondary none developed

PRIMARY MINERALS	%	SECONDARY MINERALS Alteration products (z)	%	METAMORPHIC MINERALS	%
Essential					
andesine	55	saussurite aggregate			
augite	43	chlorite			
		hematite			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
		somewhat chloritized augite		pyrrhotite	
Accessory (y)					
magnetite	2				

PECIAL FEATURES:

Andesine: Composition Ab_{64}; indices Ng = 1.555, Np= 1.547.

Augite: Z on C = 45.5°.

Saussurite aggregate: appears to consist of clinozoisite, lawsonite and possibly albite.

LASSIFICATION Andesine - Augite Diabase

PETROGRAPHER
R. W. Edie

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DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ite Collected September 1947
llector R. W. Edie

Specimen No. E 27
Locality Cameron River
Reference Volcanic Belt
N.W.T.

. FIELD NOTES
Occurrence: dyke
Question:

. HAND SPECIMEN DESCRIPTION
Color: f.s. greenish black w.s. brownish grey
Grain size: fine grained 1 mm.
Texture: equigranular
Alteration:

Munsell No.
f.s. N2
w.s. 5YR3/1

. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: porphyritic
Structure: original amygdaloidal secondary none developed

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
augite	35				
andesine	45				
Varietal (x)					
magnetite	19	GROUNDMASS OR CEMENT		MINERALIZATION	
olivene	1	fine grained intergrowth of andesine and vermicular magnetite		calcite quartz	
Accessory (y)					

PECIAL FEATURES:

Andesine: composition Ab_{51}; anhedral form; indices Ng = 1.562, Np = 1.554.

Augite: euhedral phenocrysts; Z on C = 45°.

Magnetite inclusions in feldspar form a grid pattern probably determined by crystallographic directions of the feldspar.

LASSIFICATION Magnetite Basalt Porphyry

PETROGRAPHER
R. W. Edie

V APPENDIX B

PHOTOMICROGRAPHY

EQUIPMENT

Camera:

R.B. Cycle Graphic, Folmer and Schwing Division, Eastman Kodak Co., Rochester, New York, equipped with Zeiss Kodak anistigmat F 6.3 lens No. 5.

Petrographic Microscope:

Leitz 3M microscope with 8X Huyghens ocular and objective No. 3, 10X.

Light Source:

Spencer Lens microscope lamp, 30 watts.

Film:

Kodak Contrast Process Ortho, cut 5" x 7".

Developer:

Kodak Developer DK-50.

NOTES ON PROCEDURE

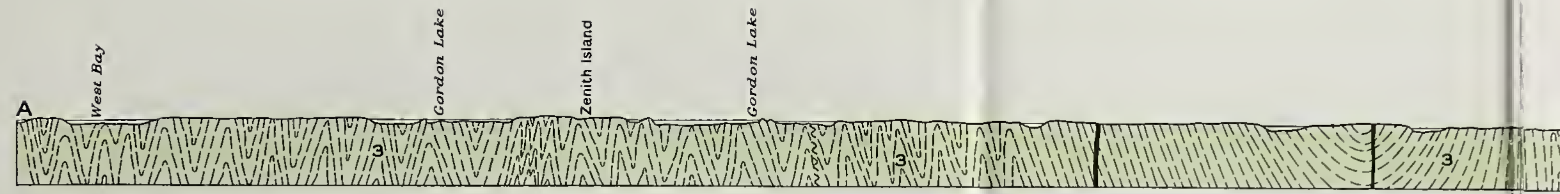
Camera set approximately one inch above ocular of microscope. Lens of camera open at F6.3 and set at infinity focus. Light source reflected off the mirror up through the microscope. Focussing done on ground glass with lamp set at rheostat 8. Rheostat adjuster set at 6 for X nicols, 5 for plain light. Exposure time controlled at light source.

CANADA

DEPARTMENT OF MINES AND RESOURCES

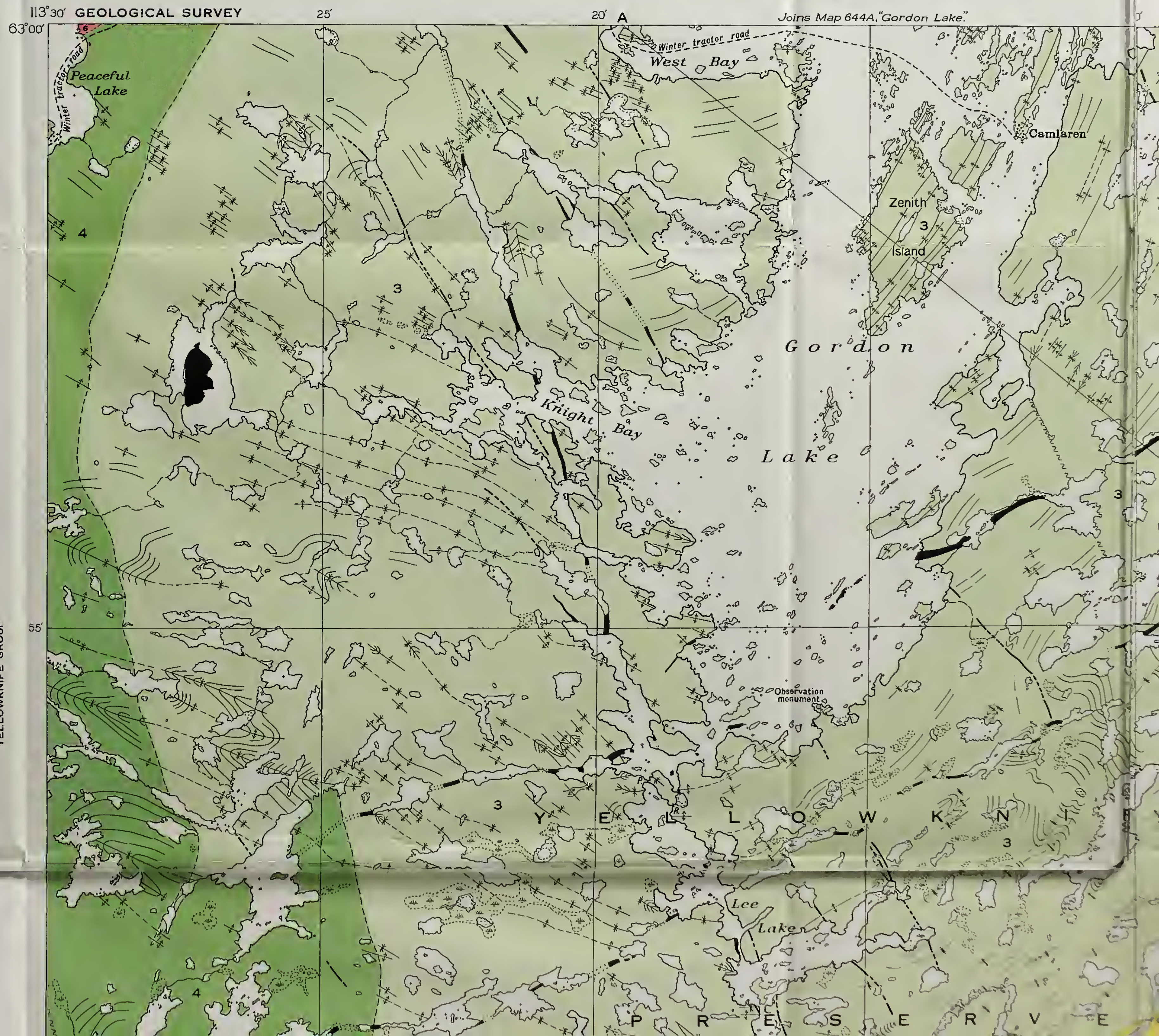
MINES AND GEOLOGY BRANCH

BUREAU OF GEOLOGY AND TOPOGRAPHY



Structure section along line A-B
Horizontal and vertical scale the same as that of map.

GEOLOGICAL SURVEY



LEGEND

PROTEROZOIC (LATE PRECAMBRIAN)

Diabase, gabbro, diorite

6 Granite

ARCHEAN (EARLY PRECAMBRIAN)

5 Granodiorite, quartz diorite and allied granitic intrusives; 5a, granodiorite, etc. with abundant inclusions of hornblende and biotite gneiss and schist

3 Greywacke, slate, impure arkose and quartzite

4 Knotted quartz-mica schist and hornfels derived from and grading into (3)

2 Rhyolite, tuff and agglomerate

1 Andesite and dacite, basalt, interbedded tuff and agglomerate; minor basic intrusives; 1a, andesite, etc. cut by many granitic dykes

YELLOWKNIFE GROUP

Area in which hornblende gabbro dykes are numerous

Trend of bedding (Beds are steeply inclined to vertical throughout the area and in many placea are overturned)

Bedding (upper side of lava flow faces as indicated, direction of dip unknown)

Anticlinal axis (observed, inferred)

Synclinal axis (observed, inferred)

Fault, ahear zone

Winter tractor road

Portage

CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

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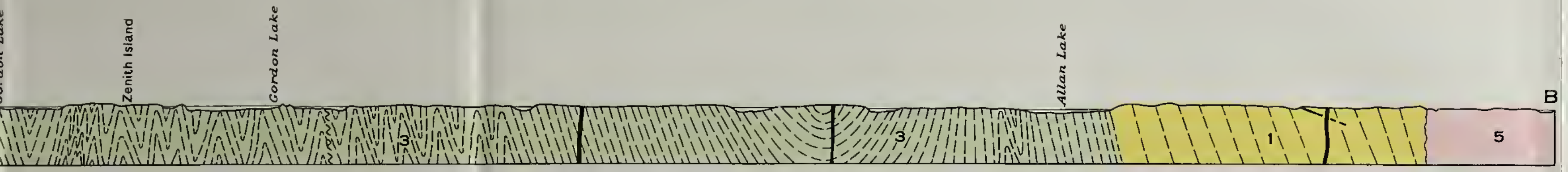
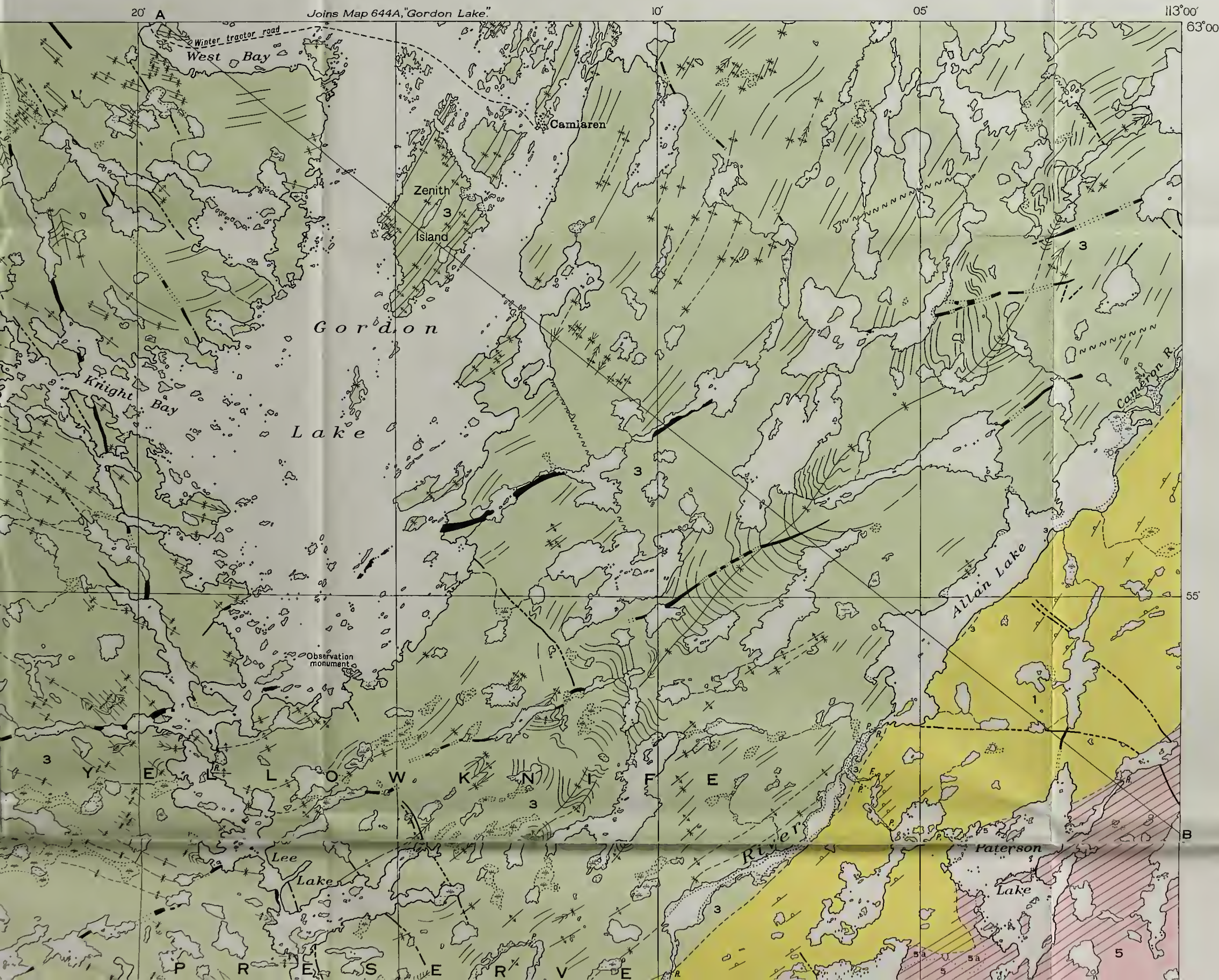


Structure section along line A–B
Horizontal and vertical scale the same as that of map.



DESCRIPTIVE NOTES

Most of the volcanic rocks (1) are older than the sedimentary formations (3, 4). They are greenstones similar to the pillowed lavas and associated pyroclastic rocks found in other parts of the region. Their contact with the granodiorite and quartz diorite is marked in places by a zone of greenstone (1a) cut by numerous dykes related to the intrusive mass and ranging from granodiorite to quartz diorite.

The division of the sedimentary rocks into relatively unaltered strata (3) and knotted quartz-mica schists and hornfels (4) is based on degree of metamorphism; a complete gradation exists between them. The greywacke, slate, impure arkose and quartzite are interbedded with one another and vary in proportions in different parts of the map-area. A narrow band of conglomerate occurs at the base of the sediments 3 miles south of the area east of the south end of Ross Lake. The conglomerate is apparently structurally conformable with the underlying volcanic rocks but may represent an erosion interval. Within the map-area no conglomerate was observed and sedimentary beds are intercalated with upper members of the volcanic assemblage and are succeeded by the main body of sedimentary strata without evidence of any erosional interval.

Alteration of the sedimentary rocks is marked by the development of mica flakes along cleavage planes, as a result of which the rocks split along glistening micaceous surfaces. The more massive strata do not cleave readily and form quartz-mica hornfels. Both mica schists and hornfels are characterized by abundant spherical or ovoid knots that represent stages in the formation of new minerals. The knots may be 2 or more inches long but average ¼ to ½ inch. They are usually more resistant to erosion than the enclosing rock and stand out conspicuously on the weathered surface but in some beds they weather away to give the rock a pitted appearance. The knots vary from an early stage of indefinite shadowy aggregation to an advanced stage in which they appear as well defined crystals of cordierite and chiastolite. These metamorphosed rocks retain much of their original sedimentary structure. Bedding is perfectly preserved and a gradation in grain size can be recognized in many beds.

Throughout the map-area the sediments lie in a series of steeply dipping, closely spaced, isoclinal folds that in many places are overturned. Synclinal and anticlinal axes were located by determining the tops of beds, chiefly by observing the change in grain size from coarse at the bottom to fine at the top of a bed. Lines on the map showing the trends of bedding were sketched from aerial photographs. The extremely close folding within the basin of Gordon Lake is due in part to the less competent, argillaceous character of the beds as compared with the more massive, sandy strata to the east and west where the folds are more widely spaced. Near the southern boundary of the map-area, close to their contact with the volcanic rocks north of Dome Lake, the beds are intensely contorted and drag-folded; elsewhere the fold axes are more nearly parallel over large areas. The folds plunge at steep angles and the direction of plunge reverses within short distances along many of the fold axes. The volcanic rocks also dip at steep to vertical angles and

ARC
(EARLY PR

2 Rhyolite. tuff and agglomerate

1 Andesite and dacite. basalt. interbedded tuff and agglomerate, minor basic intrusives, 1a, andesite, etc. cut by many granitic dykes

YELLOWKNIFE G

Area in which hornblende gabbro dykes are numerous

Trend of bedding (Beds are steeply inclined to vertical throughout the area and in many places are overturned)

Bedding (upper side of lava flow faces as indicated, direction of dip unknown)

Anticlinal axis (observed, inferred)

Synclinal axis (observed, inferred)

Fault, shear zone

Winter tractor road

Portage

Building

Mine shaft

Oil tank

Observation monument

Stream (position approximate)

Fall and rapid

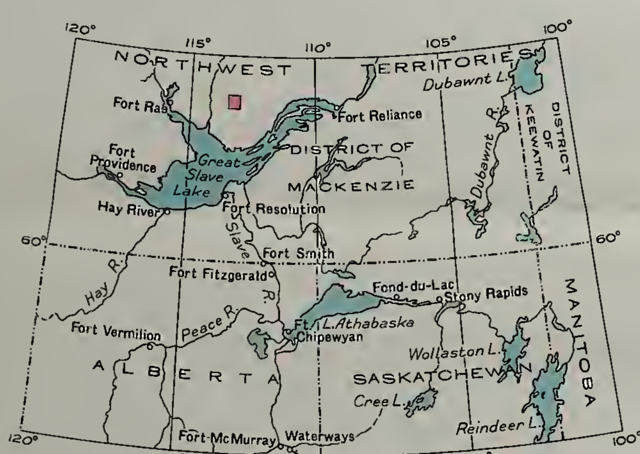
Wharf

Reef

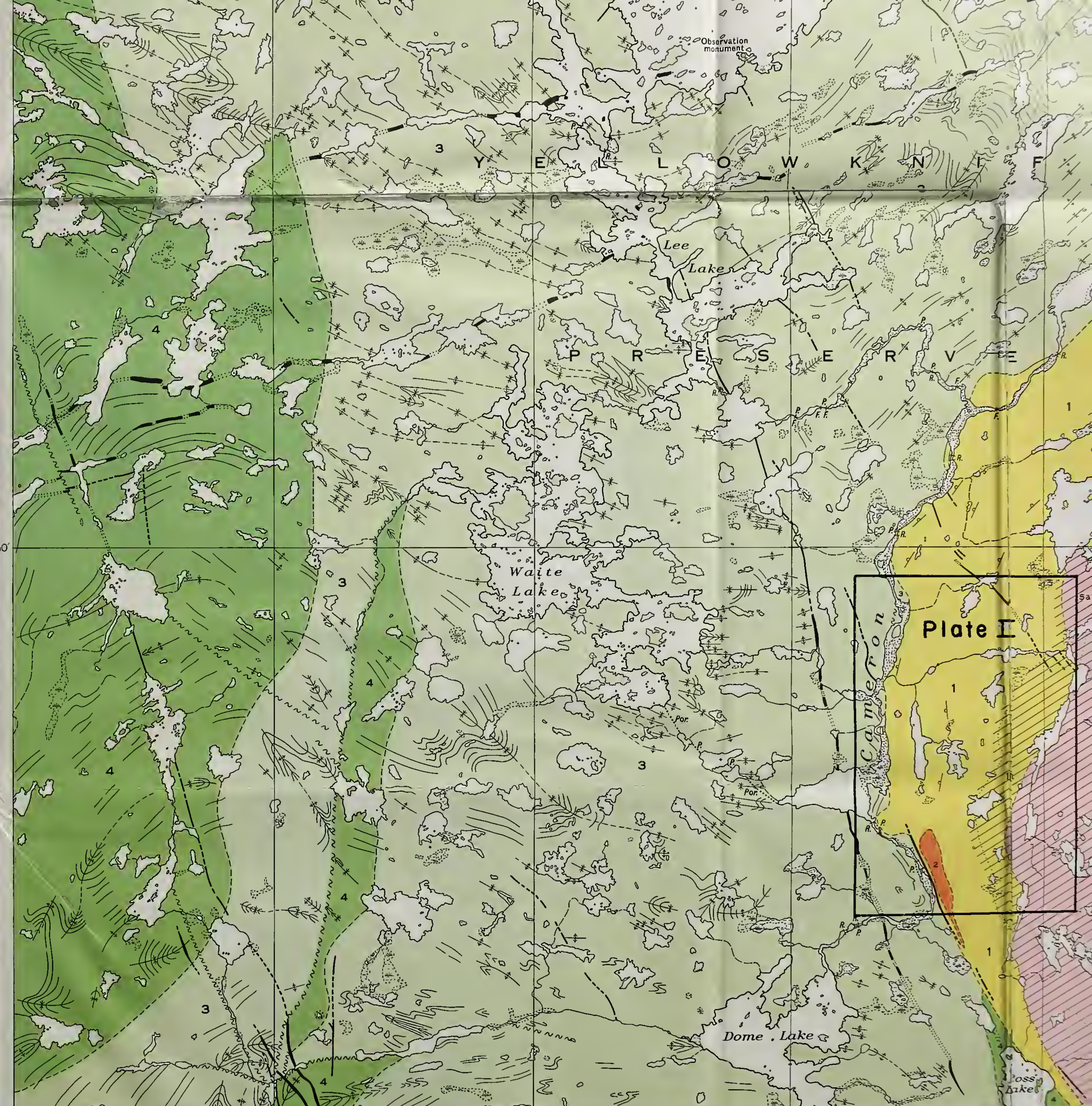
Marsh

Geology by J. F. Henderson. 1938, and 1939.

Base-map compiled by the Topographical Survey, 1939, from aerial photographs taken by the Royal Canadian Air Force, July and September, 1937. Cartography by the Drafting and Reproducing Division, 1941.



SCALE, 1 INCH TO 200 MILES



62°45′ 113°30′ PUBLISHED, 1941. 25′ 20′ 15′ 10

MAP 645A

GORDON LAKE SOUTH

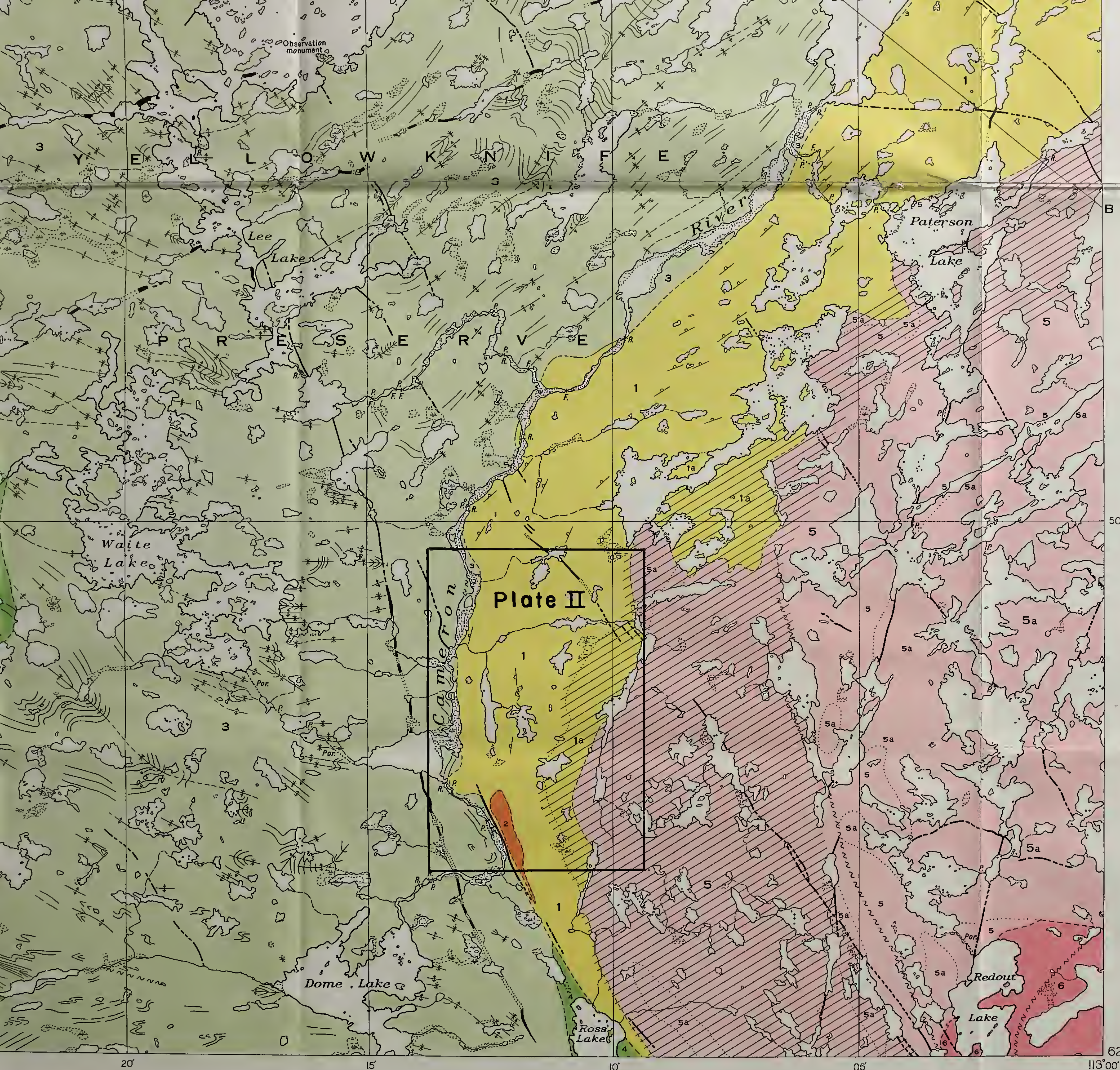
DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

Scale, $\frac{1}{63,360}$ or 1 Inch to 1 Mile

Miles

Approximate magnetic declination, 36° East.



MAP 645A

GORDON LAKE SOUTH

DISTRICT OF MACKENZIE

NORTHWEST TERRITORIES

Scale, $\frac{1}{63,360}$ or 1 Inch to 1 Mile

Miles

1 0 1 2 3

Approximate magnetic declination, 36° East.

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The granodiorite, quartz diorite and allied intrusive rocks (5) comprise a heterogeneous assemblage that varies in appearance and composition from place to place. They weather pink to grey and are composed of quartz, oligoclase, biotite or hornblende and some microcline. The quartz grains have a sugary, granulated appearance and the biotite flakes are broken. Large areas of granodiorite and quartz diorite contain abundant inclusions of hornblende-biotite gneiss and schist (5a). The inclusions vary from angular fragments to streaky, schlieren-like masses. Locally they make up as much as 50 per cent of an outcrop area.

Hundreds of hornblende gabbro dykes cut the granodiorite, quartz diorite and adjoining volcanic rocks between Ross and Paterson Lakes. The dykes range from less than a foot to more than 150 feet wide and strike in general about south 20 degrees west. They are dark green to black, medium to rather fine-grained rocks, composed of hornblende and labradorite. Some of the dykes carry scattered phenocrysts of white-weathering feldspar up to one and even two inches long.

The granite (6) is a medium to rather fine-grained, pink-weathering rock composed of quartz, microcline, orthoclase, oligoclase and biotite. Dykes and irregular offshoots of this granite cut the other granitic intrusives (5) and the hornblende gabbro dykes.

The basic dykes weather red-brown and are composed of about equal amounts of pyroxene and plagioclase.

Many quartz veins occur in the sedimentary and volcanic rocks. In the sedimentary rocks veins have been observed along the axial parts of isoclinal folds; along faulted drag folds and sheared slaty beds between those of more massive strata; and following bedding planes. Several veins have been found to carry gold but no deposits of commercial size and grade have yet been developed. The gold-bearing veins are sparsely mineralized with one or more of several sulphides including pyrite, pyrrhotite, arsenopyrite, chalcopyrite, sphalerite and galena.


N
UNMAPPED
UNMAPPED
CAMERON RIVER
MURPHY LAKE

CAMERON RIVER VOLCANIC BELT

GORDON LAKE SOUTH

DISTRICT OF MACKENZIE NORTHWEST TERRITORIES

SCALE IN FEET

500 0 500 1000